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Evening Meeting.

Monday, May 4th, 1863.

Colonel P. J. YORKE, F.R.S., in the Chair.

NAMES of MEMBERS who joined the Institution between March 16th and May 14th.

LIFE.

Molyneux, W. H. Mitchell, Lieut. R.N. 9*l*.
Hamilton, John, Capt. late H.M. Beng. Cavalry. 9*l*.

ANNUAL.

Douglas, R. S. S., Lieut. Gren. Guards. 1*l*.
Hunt, H. B., Master R.N. 1*l*.
Seymour, G. A., Captain R.N. 1*l*.
Langford, T. N., Captain R.N. 1*l*.
Molony, C. M., Lieutenant R.A. 1*l*.
Tupper, M. C. S., Lieut. 29th Regt. 1*l*.
Bedford, R. T., Captain R.N.
Forsyth, J., Lieut. H.M. Beng. Staff Corps.
Verney, Major, Sir Harry, Bart., M.P. 1*l*.
Cary, L. F. B., Lieut. Rifle Brigade. 1*l*.
Malcolm, R., Major R.E., Bombay. 1*l*.
Cunningham, A. W., Lieut. R.A. 1*l*.
Bolton, F. J., Capt. 12th Regt. 1*l*
Gascoigne, W., Lieut. Sco. Fus. Gds. 1*l*.
Bullock, C. J., Commander R.N. 1*l*.
Edmeades, H., Lieut. R.A. 1*l*.
Macdonald, C. K., Major late 42nd Highlanders. 1*l*.
Lane, C. L., Lieut. 7th Fus. 1*l*.
Gorges, A. H., Lieut. R.H.A. 1*l*.
Stuart, H. B., Lieut. H.M. Beng. Army. 1*l*.
Wingfield, Hon. M., Lieut. 1st Life Gds.

ON TELEGRAPHY FOR NAVAL AND MILITARY PURPOSES.

By Captain F. J. Bolton, 12th Regiment, F.R.G.S.,
Assoc. Inst. C.E.

The subject, to which I hope to claim your attention this evening for a short time, is that of *telegraphy generally*, but more especially that portion of it which is adaptable to the *military service*, and applicable for the purpose of signalling in the field, either by day or night.

That telegraphic communication is of the utmost importance in warfare, we have the most conclusive evidence, and that its importance and use has for ages been recognised we also know by the history of the Punic war, 264 years B.C. *Polybius* informs us even of the particular description of telegraph used, which it appears consisted of five posts placed between two walls, upon which posts, boards were fixed perpendicularly, having inscribed upon them a section of the Greek alphabet, which was divided into five parts.

A torch being held over the wall on the right of any particular post indicated the section in which the first letter of the idea to be communicated was to be found; and upon this signal being acknowledged in a similar manner by the distant station, the particular letter was signalled by a number of torches being displayed corresponding to its position on the board, thus, the first letter would be distinguished by 1 torch, the second by 2, and so on up to 5. This,to us, doubtless seems a very clumsy arrangement, and the speed at which it could be worked would be about two or three letters a minute.

The Aborigines of North America had their signal stations or mounds upon the summits of their loftiest hills and mountains, and beacon fires were there built up, whose smoke by day, and red flames by night, communicated intelligence to others far distant.

Nearly all savage and barbarous races adopt this means of communication to inform each other that enemies are in the country. It may therefore be considered a signal of ancient and very universal application. Amongst the most primitive of telegraphs used for army purposes was a moveable mast with a barrel at the head, and a flag and basket suspended beneath it; all the parts were moveable, and simply arranged signals could be indicated: thus, on the approach of the enemy the pole was left bare, so that the object of its use might not be suspected; any transposition of the other parts, alone or combined, would be made to communicate a variety of information.

Various other descriptions of telegraphs have at times been used, but the most perfect one in every sense of the word, as far as aerial telegraphs are concerned, was that which was invented and perfected by Messrs. Chappé, and first introduced in France in 1790. It consisted of a bar of wood placed horizontally on an upright mast, in the shape of the letter T; at the two ends of this horizontal bar were placed two wing pieces of wood. All these parts were moveable at pleasure, and by placing them at different angles, by means of a

combination of ropes and pulleys, no less than 192 signals could be produced.

Yet such was the prejudice that existed at this time (1791) against the establishment of telegraphs, that the *first stations erected* were ruthlessly destroyed by the populace, and when again rebuilt, were burnt down.

Notwithstanding the great opposition and discouragement met with, the inventors persevered, and in a few years succeeded in again re-establishing their lines of communication, but it was not until two particular despatches of considerable interest to the French nation were transmitted that the fate of the telegraph was decided. The first of these despatches was sent from the frontier of France to Paris, and consisted of the following words:—"*Conde is taken from the Austrians.*" The response from the Convention, received at the frontier was, "*The army of the North deserves the gratitude of the country.*"

These two telegraphic messages, spreading with the rapidity of lightning, soon became known to all Paris, as well as to the army of the North, and the victory and the telegraph were henceforth established as glorious facts.

From this time, therefore, the construction of telegraphs began to occupy the attention of men of science, not only in France, but throughout the whole of Europe and America, and until the introduction of the electric telegraph many forms of semaphores were used, all being more or less based upon the system of Chappé.

As my time, this evening, will not permit me to enter into the history of the electric telegraph—with which, probably, most of my hearers are already acquainted—I will proceed at once to the more immediate object of my lecture, which treats especially on the application of telegraphy for purposes connected with the naval and military services.

In the event of an army taking the field, its commander would naturally feel confidence in knowing that every division, brigade, or regiment had the means of communication with another by telegraphic signals, and to effect this important object, it becomes necessary that a certain system should be selected for adoption, with which every branch of the service may be acquainted; and, as the establishment or adoption *of any system* is better than *no* system at all, it has lately been proposed to the proper authorities that they should give their consideration to the subject, and suggested that such system should claim attention as admits of being easily understood with a degree of certainty under *any* circumstances, at the same time being capable of expression by various means, either by electricity, light, signs, or sound, without having recourse to colour, by which many signals in use at the present day are solely significant. My reason for excluding all colour from signals is in consequence of the existence of what is commonly known as colour-blindness, the prevalence of which amongst the community, according to the latest statistics, is quoted at above five per cent.

It is obvious, therefore, that many men may be called upon to act as signal men who (themselves unconscious of their defect) may be

more or less affected with colour-blindness; and signals solely significant by their colour, and of the utmost importance, may be thus mistaken, and the result of such mistake be the cause of the greatest disaster. Therefore, either the colour-blind should be excluded from the office of signal-men, or colour entirely excluded from all signals.

Colour-blindness being compatible with perfect vision in other respects, it would become extremely difficult to determine on a man's inability to perform the duties appertaining to a signal-man or look-out, on account of this defect or peculiarity, if possessed of all other necessary qualifications.

The difficulty of determining the state of vision with regard to the distinction of colour in the whole army, or even of a single regiment or corps, being very great, the desirableness of a system of telegraphy, from which all colours should be excluded, and in which the colour-blind cannot make mistakes, will at once become evident.

As the subject of colour-blindness is not very generally understood, perhaps it will not be out of place if I here say a few words in connection therewith, as far as it concerns the present subject of telegraphy.

Colour-blindness, or an inability, more or less complete, to distinguish one colour from another, has been the subject of research and inquiry of a great number of able and eminent men, both in England, on the Continent, and in America, during the last seventy or eighty years, the result of whose experience has brought to light the existence of a remarkable limitation of vision in reference to colours. Colour-blindness, as it shows itself in eyes, to all other intents normal, may be considered as of three kinds:—

1st. Total inability to discern any colour, so that light and shade, or black and white, are the only variations of tint perceived.

2ndly. Inability to discriminate between the nicer shades of the more composite colours, such as browns, greys, and neutral tints.

3rdly. Inability to distinguish between the primary colours, red, blue, and yellow, or between these and the secondary or tertiary colours, such as green, purple, orange, and brown.

Total colour-blindness is, indeed, very rare; but there are on record several well-marked cases, to some of which I shall presently refer; and it is somewhat remarkable that an insensibility to colours is not only compatible with perfect vision in other respects, but is frequently attended with a very nice perception of form and outline, and of colours faintly illuminated, such as those sensible to colours do not possess.

This, however, can easily be accounted for, as the eye, unfatigued by the impression of colour, will preserve a sensitiveness to faint light, such as an ordinary eye, exhausted by tints of all kinds, cannot possibly retain.

The statistics of colour-blindness are as yet imperfect, and do not include females; but there is every reason to believe that the number of males in this country who are subject, in some degree, to this affection of vision is not less than 1 in 20, and that the number markedly colour-blind—that is, given to mistake red for green, purple for blue, and occasionally red for black—is not less than 1 in 50. The actual

number of the markedly colour-blind, detected in an examination of 1,154 males, in Edinburgh, was 1 in 55; and the parties thus examined were students, soldiers, and policemen, born in various parts of the British dominions.

We may thus, according to our present knowledge, regard 2 in every 100 of the community as seriously defective in their perception of colour, supposing the colour-blind to be equally divided amongst the population, but as direct observation, as well as the prevalence in certain families of colour-blindness demonstrates that the division is very unequal, it is impossible to calculate the extent of its prevalence in any limited area, whilst it is certain that the evils which it entails on its subjects and others will be lessened in one district, only by increasing in another.

The examination, to which I have just alluded, was made by Dr. Wilson, of Edinburgh, and is thus described by him:—

"The investigation was made by daylight, in the latter part of October, 1853, and as the leisure accorded to a soldier in a short winter day, could not be largely encroached upon, it was impossible, though some hours were devoted daily for nearly a fortnight to the inquiry, to make other than a rapid examination of each individual. Accordingly it being desirable to ascertain how far the prevalence of colour-blindness in the community rendered the red and green signals in use on our railways unsafe, observations were almost entirely confined to the difficulties attending the discrimination of red from green, and brown from green; mistakes between other colours being noticed only when they prominently presented themselves, though even then they were not always recorded."

"The men were examined one by one; in the first place by asking them to name coloured papers, or the diagrams in Hay's nomenclature of colours. Their catalogue of names, unless they had previously followed trades conversant with colours, was in all cases exceedingly scanty, including in general only the terms, red, blue, yellow, green, and brown (which last, however, was often wanting); purple being scarcely ever named, and orange, I may say, never. By requesting them, however, to refer the colours shown them to red, blue or yellow, all necessity for precise terms, in the case of compound tints was dispensed with, and the risk was avoided of confounding those who could not name colours, with those who could not distinguish them. The majority answered promptly in reference to red, blue and yellow; purple was generally called either blue or brown, but was nevertheless distinguished from these colours, when shown side by side with them; orange was most invariably called red, and there was great uncertainty as to the difference between green and blue. Those who gave reasonably intelligent answers in reference to the names of the primary and secondary colours, were dismissed without further inquiry; but if any marked hesitation was shown in distinguishing red from green or brown, they were asked, without naming them, to assort coloured papers, wools, and pieces of glass, and to place those of the same hue together.

"Proceeding in this way, 31 colour-blind persons were found among

437 soldiers of the 4th King's Own Infantry; of these, 5 confounded full red with full green, and 1 pink with light green; 13 counfounded brown with green, and 12 blue with green.

"Among 177 soldiers of the 7th Hussars, 14 were colour-blind; 4 mistaking full red for full green, and 1 pink for light green; 2 brown for green; 6 blue for green, and 1 yellow for pink.

"Of the detachment of Artillery at Leith fort, 123 were examined, 5 of whom were distinct cases of colour-blindness, and 2 were doubtful. The list thus given, errs by defect, not excess, especially in reference to the confusion of red with green. In so rapid an inquiry as was made, only the more prominent cases could be detected; and timorous, sulky, obstinate, or unwilling witnesses, had frequently to be dismissed, though their cases were suspicious, rather than prolong the detention of a company or troop who were waiting to be examined man by man. Those, however, who distinctly betrayed a tendency to confound red or brown with green, were very carefully examined, and the attention of the officers present, was directed to the mistakes made, so as to secure us against any attempt at deceit on the part of the men."

No fact is better ascertained than that colour-blindness clings to certain families, and is hereditary. It seems, indeed, a safe estimate that every decided case of colour-blindness implies the existence of another case of equal or similar severity in the person of a relative, so that the numbers given as representing the proportion of colour-blindness in the community may be fairly doubled.

Perhaps it is worth a moment's consideration how far this peculiarity of vision characterises one race of men more than another.

It is doubtless more common amongst the civilised nations, large numbers of whom are doomed by that division of labour, which is a great source of their strength, to occupations which dwarf one or more of their external senses, than it is among the uncivilized races, each member of which cares only to do what is right in his own eyes, and cultivates the powers of those eyes to the fullest. Among both the civilized and uncivilized nations, however, are doubtless great differences in original endowment, so far as the sense of colour is concerned; and as may be reasonably surmised, there are corresponding differences in the extent to which colour-blindness prevails among them. Thus those Eastern and Southern nations, who live under bright skies, amongst plants, birds, and animals of vivid and brilliant colours, exhibit, partly as a prerogative of race, partly and largely as an effect of such colours daily impressing them, a delight and skill in arranging matching, and harmonizing tints, such as are incompatible with colour-blindness, and imply its rare occurrence amongst those whose love of colour and command over it are so great.

The professions, or callings, for which colour-blind persons are seriously disqualified are those of a sailor and railway servant, who have daily to peril life and property on the indication given by a colored lamp or flag. Fortunately, a ship is seldom under the guidance of a single person; and in Her Majesty's vessels, the signal men are generally selected from a large number, and are ascertained to have a

quick eye for colour. In our merchant service the choice must necessarily be made from a much smaller number; and the appalling yearly number of lost ships awakens the suspicion that more than one of these fatal disasters may have resulted from the mistaken colour of a lighthouse, beacon, or harbour-lamp, which, on a strange coast, and with, perhaps, the accompaniments of a snow storm, or thick fog, has been mistaken by a colour-blind pilot.

On railways the danger attending mistakes of signals is much greater than at sea, especially in this country, where trains travel at a very high speed, and succeed each other at very short intervals. The most marked peculiarities of the colour-blind are shown in mistaking bright red for green, dark red for brown, red for black, and dark or bright shades of all colours for each other. The caution signal (green) is thus liable to be mistaken for the danger-signal (red), and the latter (when it appears black) not to be seen at all. Our railway directors have, indeed, been most unfortunate in their selection of red and green for coloured signals, especially as seen through the day on flags. These colours are mistaken for each other by certain of the colour-blind, even when fresh and bright. As they darken with use, they become objects of perplexity to an additional number of such persons, and at a distance whether new or old, they are mistaken by many, who can distinguish them near. Further, they are liable, when imperfectly illuminated (as in twilight, in fogs, or snow-storms), to become altogether invisible; so that, in short, just when it is of greatest importance that they should be seen, they are most liable to be misapprehended, or not seen at all.

The principal object, therefore, that should be kept in view in the selection of a telegraphic system is the rejection of all colour, so as to meet the objections already advanced with regard to the colour-blind, and the adoption of such means as to render intercommunication, either by day or night, easy and certain; and for these reasons I should prefer for day signals the use of any object that has a different aspect in any two positions, or is capable of any two distinct motions, and for night one bright white light only; and although it may possibly be thought that great facilities might be added to the telegraphic arrangements by using lights of various colours, yet when it is remembered how prevalent is colour-blindness, and how differently colours are named and estimated by different people at night, and how fog and rain affect these colours, it will be readily understood that the simplicity of one uniform light is preferable.

Any code of signals can be used, but in my opinion the best is that which takes, as the base upon which it is formed, the point and the bar; and the best of these two symbols is that arranged on the same principle as the compositors' alphabet, the letter most frequently used—viz., E—being expressed by the shortest and simplest symbol, and so on in succession. The numerals being expressed in a manner to speak for themselves; thus 1 to 5 being their relative number of dots, and 6 to 10 the same number of bars. This code is a modified form of the one used by Professor Morse. Taking the point as the unit, each bar is the length of three points. A space of three points is left

between each letter or number, and the length of six points between each set of numbers or word, as shown in the code here arranged:—

CAPTAIN BOLTON'S FLASHING SIGNALS.

ALPHABET.

A	▪ ▬
B	▬ ▪ ▪ ▪
C	▬ ▪ ▬ ▪
D	▬ ▪ ▪
E	▪
F	▪ ▪ ▬ ▪
G	▬ ▬ ▪
H	▪ ▪ ▪ ▪
I	▪ ▪
J	▪ ▬ ▬ ▬
K	▬ ▪ ▬
L	▪ ▬ ▪ ▪
M	▬ ▬
N	▬ ▪
O	▬ ▬ ▬
P	▪ ▬ ▬ ▪
Q	▬ ▬ ▪ ▬
R	▪ ▬ ▪
S	▪ ▪ ▪
T	▬
U	▪ ▪ ▬
V	▪ ▪ ▪ ▬
W	▪ ▬ ▬
X	▬ ▪ ▪ ▬
Y	▬ ▪ ▬ ▬
Z	▬ ▬ ▪ ▪

NUMERALS.

1	▪
2	▪ ▪
3	▪ ▪ ▪
4	▪ ▪ ▪ ▪
5	▪ ▪ ▪ ▪ ▪
6	▬
7	▬ ▬
8	▬ ▬ ▬
9	▬ ▬ ▬ ▬
0	▬ ▬ ▬ ▬ ▬

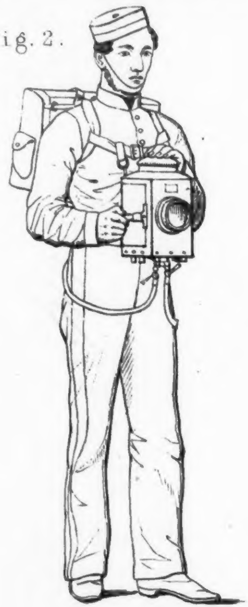
PARTICULAR SIGNALS.

Attack . .	▬ ▪ ▬ ▪ ▬ ▪ ▬
Finis . .	▪ ▬ ▪ ▬ ▪ ▬ ▪
Repeat or ?	▪ ▪ ▬ ▬ ▪ ▪
Numbers .	▪ ▪ ▪ ▬ ▪ ▪ ▪
Understood	▪
Erasure. .	▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪
Period . .	▪ ▪ ▪ ▪ ▪ ▪
Alarm . .	▬▬▬▬▬

NOTE.—A flash represented by a point is equal to about one-tenth of a second; each bar is equal to three points; a pause of three points to be made between each letter or number, and a pause of six points between each word or set of numbers.

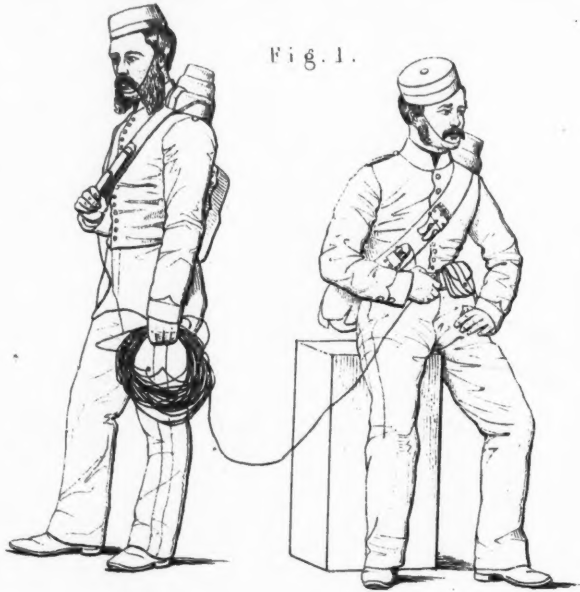
ar is
mber,

Fig. 2.



CAPTAIN BOLTON'S
Portable Lime Light Signal Apparatus with compressed Gases carried in a Knapsack.

Fig. 1.



CAPTAIN BOLTON'S
Portable Field Electric Telegraph.

J.R.Jobbins.

Having thus chosen or decided upon the symbols to be expressed, the next thing to consider is the means by which their expression can be obtained under the various circumstances in which they may be required.

The electric telegraph instruments of the day already provide most of the means best adapted for use in the field. The single-needle instrument, for rapid interchange of messages; the Morse printing-instrument, for recording important and cypher communications; and a small modified form of the Morse instrument (where the signals will be read by sound instead of sight, by means of a magnet striking between a stop and the helix), for obtaining secret information, or working in an enemy's position. This last description of instrument should be carried by one man, in the form of a set of accoutrements, the indicator on the shoulder, close to the left ear, the battery in his pouch, and the finger-key, or contact-maker, attached conveniently to the waist-belt. Thus, with a proper supply of covered wire, each man would represent a complete telegraphic station in himself, being able either to send or receive messages. (Fig. 1, Plate xxv.)

The same symbols or elements which compose the alphabet are used with all these instruments. On the single-needle instrument, the point or dot is indicated by a deflection of the needle to the left, and the bar or dash by a deflection to the right. On the recording instrument, the points and bars are printed off as written, by the circuit of the current being more or less closed; and on the acoustic instrument these symbols are signified by producing certain sounds, of short or long duration.

Thus, as far as the electric telegraph is concerned, everything is rendered simple and effective by using this one system with each description of instrument, whichever, under various circumstances, it would be most desirable to work with.

As there must be many cases on service, in which it is impossible to use the electric telegaph, in consequence of the movements of an army, the probability of interruption by the enemy destroying the wires, and various other causes, it is necessary that we should possess other means at hand to serve as an auxiliary to the electric telegraph, and supply its place, as occasion may require. We must, therefore, have recourse to visible or aerial signals. Now as, next to electricity, light travels the quickest, and as artificial light can be made available for telegraphic purposes, and messages transmitted from point to point within the range of vision at a rate of speed but little inferior to the recording electric instruments, it has lately been acknowledged that light is the next best substitute to electricity, especially when we consider this fact, that light signals are equally visible by day as by night, provided the eye is in a fit state to receive the impression.

This object is effected by the employment of an intensely powerful light, consisting of either the electric or the lime light, which is to be alternately obscured or eclipsed, and uncovered, so as to produce visible flashes of light of long or short duration, and in any desired order of succession.

In combination with this light, lenses, reflectors, or other well-known

optical arrangements, are used in order to prevent the dispersion of the light, and more effectually to concentrate or project it in the form of a pencil of rays upon the distant station or observer.

In conjunction with this apparatus for transmitting the light, the signals are received in a darkened chamber, or other convenient appliance, through a lens, or on a reflector, whereby they are concentrated on a field, from which all unnecessary rays of light are excluded. By these means, the eye of the observer being relieved from the redundant or extraneous light, will be enabled more readily to perceive and note the signals that are made at the distant station. The light whereby the signals are produced may be obscured or displayed—that is, the shutters or discs may be raised and lowered by causing electro-magnets to act on armatures connected with the shutters.

These electro-magnets may be put in action from a distant station by causing a current of electricity to pass through the coils of the electro-magnets in any of the well-known modes of working electro-magnetic apparatus. Thus, were it intended to establish a communication across the Channel from Dover to Calais, the light instruments at Dover would be worked by the telegraph clerk in London, and the clerk at Calais would receive the signals actually caused by the London manipulator; and while in the act of sending the message on to Paris, would repeat the light signals back to Dover.

Thus the same symbols which form the code for the electric telegragh, and which I have already described, are equally available for light-signals, either by day or night.

The importance to the service of a rapid interchange of messages, between one station and another, or between the shore and ships, or at sea, is so obvious, that any plan by which the extension of such communication can be made available, is worthy of the greatest attention; and being impressed with this idea, I have of late devoted considerable time and application to the subject, and I am happy to say my efforts up to the present moment have not been unsuccessful. During the last two years I have been almost exclusively employed in carrying out experiments with light signals, and these experiments have been attended with some most interesting results. Signals have been exchanged from the Crystal Palace to Aldershot, a distance of 35 miles. Across the channel, from Dover to Calais, from the Isle of Wight to Portsdown Hill defences, and at other ranges and distances, varying from 5 to 35 miles according to the nature of the country; and with the best operators, a speed of 17 words per minute has been attained.

The advantages of this system of telegraphy, as an auxiliary to the electric telegraph, will be obvious when I mention that a communication can be established between the troops in a besieged town and a fleet or force coming to their assistance, over the heads of the besiegers without the possibility of interruption, and with very little chance of interpretation, as the messages could be sent in cypher.

The light that I have chosen to serve as a telegraph light for field and army purposes generally, is the lime, or, more properly speaking, the oxy-hydrogen light, which, although not to be compared for intensity

to the electric light, yet possesses all the necessary qualities for field purposes, as it would seldom be required for distances beyond 20 miles.

Selecting this light, I have therefore had to consider the best means of obtaining the gases to produce it, and to reduce it to a cheap and portable form, and the result is the apparatus now before you—this box, which is about two feet square, contains everything that is necessary to produce the oxygen and hydrogen gases, the action of which gives us what is commonly known as the lime light, of which, for the benefit of those not informed upon the subject, I will give a short description.

The light is obtained from the ignition of a piece of lime, by submitting it to the intense heat evolved by the compound flame of hydrogen and oxygen gases in the proportion in which they form water. The lime does not burn, but simply becomes brilliantly illuminated, without undergoing any chemical change. This light, therefore, is independent of the atmospheric air, and cannot deteriorate it. The light produced is the most intense and purest known, with the exception of the electric light, from which it differs, however, in some important particulars. It is perfectly steady and continuous, and its volume may be increased at pleasure. Neither of these are attributes of the electric light, and in the points of expense and simplicity, the lime light is far superior. Drummond was the first who applied the lime light to purposes of practical utility, and by his experiments it was shown decisively that its range was practically unlimited, for he connected the shores of Wales and Ireland by the light at Holyhead, a distance of 64 miles, and afterwards obtained a like result at the summits of Ben Lomond and Knock Larg, a distance of 95 miles. His light, however, wanted these two special properties—volume, without which no light is adapted to the means at present possessed for its distribution; and, secondly, continuity, which he could not command.

For these reasons it was condemned by Stephenson as unsuited to lighthouse purposes. In fact, with the appliances then obtainable, he could come to no other conclusion, the duration of the light being under no control. Both these difficulties have been overcome by the ingenuity of those who have followed in the wake of Drummond, for the volume can be easily increased so as to meet every practical necessity; whilst the complete control over its continuity, and the facility with which it can be permanently maintained, have been fairly proved by practical experiments. Amongst these we may mention the maintenance of the light for some seven or eight hours every night, during two months, upon the landing stage at Liverpool. It was also maintained for two months during the construction of a portion of Westminster bridge; and Mr. Page, the engineer of that structure, says, in his report upon it, "I have much pleasure in acquainting you that, since the application of the lime light upon Westminster bridge, not a single case of failure has been reported to me, and the result of my own personal experience will justify me in recommending the system for the permanent lighting of the bridge and its approaches on their completion." (This, however, does not appear to have been done.)

It has also been maintained in the South Foreland Lighthouse as a first order coast-light for several months with perfect and uniform success. In foggy weather it has been discovered that the best results are obtained with the naked light.

As regards the gases by which this light is produced, the methods of obtaining them admit of alterations for the better, not so much in the mechanical means used for producing them from their present sources, for these are very simple, but as to the sources themselves from which they are obtained.

The hydrogen is at present obtained by the decomposition of water, by the agency of zinc and sulphuric acid. A simpler method of obtaining it in greater quantity than is required for field-signals, is by the decomposition of steam passed through red-hot cast iron borings. The hydrogen can be obtained by these means very rapidly, and at a moderate cost, whereas its production by the present method is both costly and tedious, to say nothing of the objections that must always exist to the use of sulphuric acid in great quantities.

The oxygen gas is obtained by simply heating the chlorate of potass, mixed with the peroxide of manganese, or dry sand, in cast iron or other properly constructed retorts. This gas can also be obtained from nitrate of soda, or from manganese only.

Having, I trust, with this brief description made the nature of the lime light clearly intelligible, I will now proceed to describe the apparatus which I use for producing it in the field for the purpose of signalling. This case contains everything necessary for the generation of the required gases, together with an appropriate supply of chemicals, and the lantern or signal instrument. Supposing it desirable to establish a signal station in the field, some six or eight minutes is all the time that will elapse between the arrival of the apparatus, the production of the light, and transmission of the call-signal. No matches or other light is necessary to obtain the lime light, as by exposing a small piece of spongy platinum to the action of a stream of hydrogen, the gas at once becomes ignited, and thus much inconvenience is avoided; as I have found from experience how extremely difficult it is sometimes to get a light with the very best of matches, when exposed to the inclemency and storms which usually attend our winter nights.

The system of working this light is thus:—The oxyhydrogen light having been obtained, the lantern is turned in the direction of the distant station or point to be signalled to, and the light exposed until seen and acknowledged by them; when the call-signal is sent, and replied to, the message is forwarded, each word being ackowledged at the distant station, by one flash, if understood, and by a particular signal if not understood, when the word is repeated until it is. In short, this varies very little in its working from the electric telegraph, and when the light is once obtained it needs but little attention, and the consumption of the lime is so trifling, that one pencil of lime, about an inch in length, and one-fourth of an inch in diameter, will last for hours.

The gases can also be used in a compressed form, and contained in two

small cylinders* fitting into a knapsack, and carried on the back of one man, who carrying the lantern on his breast (as shown in Fig. 2), walks about as a complete station, and attends the general or other staff officer, proceeding on a reconnaisance, when doubtless his services would be found very useful to flash intelligence to the army, or to the reserve. Having explained the nature of the lime light and the signal apparatus, and having previously stated to you that it will not *bear any comparison* to the electric light for intensity, I will now show you an electric light, so that having seen them both, side by side, you may judge of their relative values; and I think you will admit that there is as great a difference between the lime light and an ordinary candle, as there is between the electric light and the lime light. This electric light is produced by 40 Groves' elements and a Serrin's lamp; and it is to be regretted that we cannot at present apply it advantageously for army signal purposes, as it lacks those very desirable attributes of *continuity, portability, and cheapness.* Hence my having recourse to the lime light, which has been found to answer all practical purposes.

You observe that this electric light is deficient in that very quality of which I have spoken, namely, continuity, The light is continually flickering; hence, it is not so well adapted for signal purposes as the lime-light, with which we can command perfect steadiness. After the electric light, the lime-light will appear very small. Here what we lose in volume we gain in intensity, and you will observe that a pencil of rays of light is projected forward. The signals are sent in the same manner as by the electric telegraph, namely, by the dot and dash. With these two symbols in combination we have formed the alphabet and also the numerals; thus, *a* would be represented by a dot and a dash; *b*, by a dash and three dots; and by sending a communication thus made, a speed of about seventeen words per minute has been obtained.

I will now send a short signal to you, and you will perceive, by looking at the reflection on the wall, how the signals will appear at a distant station. I will send the signal, "The enemy is advancing;" after having sent the "call signal," which is a steady light shown some time, the attack is sent, which consists of a dot and a dash, to show the rate of working to the distant operator. That having been acknowledged by the operator at the distant station, the signal is sent, "The enemy is advancing." (The mode of sending the signal was shown.) Each of these words would have been acknowledged at the distant station by the letter *e*, or the signal signifying that they had received it "all correct." If the message had not been understood, they would have called for a repeat, by sending "repeat," or the "query." As you see that light appear on the wall, so it would appear at the distant station—very bright. This light is capable of being turned in any direction, and is capable of adjustment to any height that may be wished.

While on the subject of light, I would wish to draw your attention

* The quantity contained in these cylinders will last 36 hours, and costs about 4*d*. per hour.

to this model of a lighthouse, in which, you will perceive, there is a revolving light; this consists of an improved mode of, and apparatus for, displaying the lights used in lighthouses, and in adapting or applying to the lamps or burners of lighthouses, any convenient contrivance whereby the light may be alternately obscured and displayed, at such intervals, and for such different periods of time, as, by a pre-arranged system of signals, will indicate a code number, or the name of the lighthouse, so that the latter may be instantly identified.* These signals are to be repeated continually at regular intervals, so that the mariner when at sea will (upon coming suddenly upon the light) be able at once to know what is the code number and name of the lighthouse, and may therefore ascertain his exact locality without risk of making a mistake. The obscuration of the light may be effected by rising and falling shutters, discs, or other analogous contrivances, actuated by clock-work, or other mechanism, or by means of an opaque cylinder, perforated in a suitable manner to give the required flashes as it passes in front of the light, or as it rises and falls at the desired intervals. The system of flashes of long and short duration being pre-arranged to represent numerals or letters, the particular code number, or name of each light, will distinguish it from any other lights. If all the lighthouses along a coast be provided with such a system of periodical signals, any lighthouse that a mariner at sea may perceive at a distance will be at once known. The signals indicating the number or name of the lighthouse will also be continually repeated at stated intervals, so that, should the mariner be uncertain as to the accuracy of his first observation, he will be able to verify his observation within a very short time, and thus prevent any chance of error if the most ordinary care be used. By means of this improved system of displaying the lights in lighthouses, one light of suitable intensity will be sufficient to give the necessary indications and signals to enable an observer to identify the lighthouse, and, therefore, the ordinary arrangements of coloured lights, revolving lights, flash lights, and a plurality of lights, will be rendered unnecessary, and the appliances for working the lights will be simplified, and a more convenient, uniform, and efficient system of signals, as applied to lighthouses, will be established.

This model of a lighthouse has a revolving cylinder moved by clock-work, making one revolution per minute; in this cylinder, slots are cut, corresponding with the symbols for the numbers 2, 1, 8, which is No. 218, and, according to the published list of lighthouses in Marryat's "Universal Naval Signal Book," indicates Port Mary, in lat. 54° 4′ N., long. 4° 44′ W.

The flashes making the number are shown in about half a minute, and during another half a minute a steady fixed light is shown. Thus, a mariner watching this light for two minutes, is twice told the number of the particular lighthouse he sees, and, therefore, on referring to his book, also knows the name, as well as his latitude and longitude.

* The credit of a similar application, I believe, belongs to Mr. Babbage, although it was not until I was informed of this by Admiral Washington that I had any idea that I was not the first who had brought the subject forward.—F. J. B.

It is shown thus:—First, you see a steady light, it is then obscured for three seconds, then you see two short flashes in rapid succession, which indicates two, then a pause, then one short flash, and a pause meaning one, after which three long flashes in rapid succession, which makes 8, after which a pause, and then a steady bright light for half-a-minute, which signifies the light has told its tale to the observant mariner, who then knows exactly his whereabouts; and if in doubt, in another minute his doubts will be set at rest.

The code signals for numbers as I have arranged them, are so simple, that they are easily within the comprehension of any intelligent seaman; and, of course, a list of these numbers would be inserted in the same signal-book which contains the list of lighthouses.

Reverting to the more immediate subjects of this paper, I regret to say, that up to the present time, we have no regular telegraphic corps organized in connection with the army; but the establishment of one is much needed. It is found, that telegraphists who do not keep up their practice continually, soon lose all their efficiency and expertness, as rapid and skilful operators; and hence the necessity of establishing a distinct corps of professed signal-men and telegraphists, who may thus be enabled to devote their whole time to this one important branch of the service, and consequently attain that proficiency which is so essentially necessary for the requirements of modern warfare.

Thus, these professed signal-men, while being kept exclusively for telegraphic purposes, and not required to do any other duty whilst so employed, would still be thorough and efficient soldiers; and being drawn from the corps of Royal Engineers, would again become ordinary sappers, if they did not prove themselves to be thoroughly good telegraphists.

It being, therefore, admitted that the necessity for the establishment of a telegraphic corps, based upon such a footing as to meet the foregoing requirements exists, it becomes important to consider what services these telegraphists would be required to perform, and the description of the instruments and apparatus to be used. Amongst the various requirements—

I.—*Electric Telegraphy.*

1.—For communication along the already established lines of this and foreign countries with the instruments at present in use, comprising the double and single needle, and the recording and acoustic Morse instruments; thus, during war, having the means of keeping more directly open the communication with the seat of war.

2.—Establishing lines, of more or less permanency, according to the nature of the services required, either at home or abroad, or in the field during active warfare; the means of doing this being provided for by a suitable and complete field equipment hereafter described.

II.—*Visible Signals.*

1.—By flashes of light available for either day or night signalling, to

serve as an auxilliary to the electric telegraph, or supply its place in situations where it is found inpracticable or undesirable to erect wires, or lay a cable.

2.—By Redl's cones, flags, balls, semaphores, or any other means which, on an emergency may be turned to account, according to circumstances; trained telegraphists being able, to a very great extent, to extemporise a code of signals suitable to any emergency, and to understand each other, and establish a communication under conditions where it would be impossible to do so, without men educated together, and thoroughly instructed in the same method and system, which must necessarily emanate from one common centre.

III.—*Co-operation of Army and Navy.*

There must be cases of continual occurrence in warfare, where it is of paramount importance that an uninterrupted communication be kept up between the army and navy acting in conjunction, as, for instance, during the late Crimean war. At present, no established means exists to effect this, neither is there any organised system of rapid (nor indeed any) communication between our forts and ships. Hence the absolute necessity of instructing men belonging to the army in the adopted methods of signalling used by the navy, and those applicable for naval purposes.

IV.—*Secret Communication and Foreign Signals.*

1.—That in the proposed corps, men should receive, as far as practicable, instruction in cypher telegraphy.

2. That the officers attached to the telegraphic corps should become acquainted and conversant *with* the particular methods of signalling and telegraphy generally practised in foreign countries, which would often afford the means of obtaining information of the utmost importance, as was instanced during the present American war, when an officer of the Southern Signal Corps, not only read off the messages sent by the Federal Government to the commander of its forces, but telegraphed replies in such a manner, as considerably to mislead the enemy, and thereby materially aid his own cause.

V.—*Co-operation with the Civil Lines.*

Telegraphists instructed as proposed, would be able to work direct from the Government offices to all naval and military stations, and it is presumed that this would be of great value during the time of threatened invasion, when by means of a field equipment, the communication could be kept open between any fixed station and the moving army of defence, or the particular point threatened.

From the nature of these specified requirements, to which many

others might be added, it will at once be seen, that each man; as well as being thoroughly grounded in an ordinary telegraphic education, must possess at least an average intelligence and a certain aptitude, which can only be acquired by long and steady practice.

The equipment should consist of a waggon containing everything necessary for the establishment of at least ten miles of communication with wire, light signals, cones, flags to communicate with the navy, and signal rockets, and in fact should be so complete in itself as to be equal to the requirements of a division of our army, the unit for which is 10,000 infantry, 2,000 cavalry, 8 batteries of artillery, and 3 companies of engineers. 10 or 12 good telegraphists and professed signalmen would be sufficient to accompany each equipment.

As it might be, perhaps, considered best to begin with few numbers, and perfect it by degrees, the establishment might consist in the first place of a school and reserve, and two perfect field equipments. Each equipment having 1 officer in command, with 2 non-commissioned officers and 10 telegraphists—the officer and 1 non-commissioned officer being mounted—these telegraphists would be employed not only as operators, but in the construction of lines, which work cannot be well and speedily done by inexperienced workmen. The horses for drawing the waggon could be detached from the military train for this duty, as is done in the medical service for ambulances. When reported fit for service, one equipment and its staff, consisting of the most efficient men should be attached to the camp of instruction at Aldershot, where they would also have charge of the telegraph lines already established there, and this equipment would thus be ready for any immediate or active service.

The second equipment should be at the head-quarters of the telegraph corps, and ready at very short notice, either to relieve or accompany the first on service. These equipments should be constantly practised in establishing telegraphic communications in conjunction with the movements of the troops, and in co-operation with the navy whenever practicable. The remainder of the corps would be attached to the school, and would consist of instructors, qualified telegraphists, and learners. Thus the superintendent, with one staff-serjeant (to do the duties of serjeant-major, quartermaster-serjeant, and pay-serjeant), 4 non-commissioned officers, including 2 instructors and 16 men, would be at head-quarters, capable of forming a third equipment if the requirements of service wanted it, and from this school, telegraphists could be detached to any station requiring their services. This reserve would have a sufficiency of men at its disposal to cover casualties.

The estimated expenditure necessary to be incurred in the formation of this corps would not much more than exceed the amount of the extra pay to the instructors, the telegraphists being already provided for in the Royal Engineer establishment, and it would be scarcely necessary to incur much outlay in providing the school of instruction with proper and sufficient materials and instruments, and in the construction of the field equipment: thus much might be done and the country possess at least the nucleus of an efficient telegraphic corps, at scarcely any expense; and as I said at the beginning of this

paper, I have proposed the adoption of this uniform system of telegraphy, because I *am convinced* that the establishment of *any system is better than no system at all*, I therefore trust that such attention will hereafter be given to this most important subject, *by abler men than myself*, as will ultimately lead to a perfect system being adopted and organised, equally adaptable for all the requirements of communication for both the naval and military services.

The CHAIRMAN: I am sure I only anticipate the wishes of the meeting in proposing that we should return our best thanks to Captain Bolton for the very valuable and interesting communication that he has made to us. We should be glad to hear any remarks that any gentleman may wish to make on the system just explained.

Lieutenant COLOMB, R.N.: As I have paid a good deal of attention to this subject, and my name has been a great deal mixed up with the question of flashing signals, and as I have considered the subject of naval and military communication by signal, and for five years have been employed by the Navy department in arranging such means of communication, I suppose it would be desirable that I should make a few remarks upon this question in a naval point of view, but it must not be supposed that Captain Bolton and I are rivals in this matter. The question of communication between the army and navy by signal, and in the army and in the navy, is a very wide one; and it has never, so far as I know, been properly treated. I look upon the question of signals altogether as one of the most unfortunate scientific questions that exist. For the rule in the study of the question has been this:—A person first invents a system of signals, then goes to work to find out what has been done before, and, lastly, he takes up the study of the subject. Nearly all the new, or rather the modern systems of signals that have been invented have been brought forward in this way. People have invented their system, and then they have afterwards set to work to study the subject. Captain Bolton hardly goes sufficiently into details in his lecture for me to make many remarks; but in the course of it he mentioned a point, and dwelt for some time upon it; and it is one on which I think it is necessary we should have clear views, viz., "colour-blindness;" and he spoke of the great difficulty of distinguishing signals by means of colour. This would have very great force in signals which depend upon colour; but the fact is, there are very few signals which do depend upon colour. The flags used in the navy do not at all depend upon colour. Colour is an accident to the distinguishing of the different flags, but it is not the means by which they are distinguished. There are only two flags in the whole forty-seven used in the navy which are dependent exclusively upon colour.

A VOICE: Three.

Lieutenant COLOMB: I stand corrected—three. That being so, the effect of colour-blindness upon signalmen does not apply to any very great extent, to a system such as is now in use in the navy. I perfectly agree with Captain Bolton in the undesirableness of using colour at all as a means of communication. I have carried out an immense number of experiments, both by night and day, with regard to colour. I have tried flags made of different forms, and I have tried flags constructed entirely of black and white colours, and in all cases I find that the difference between the distinctness of signals which are made of form and colour is very marked indeed. Colour in all cases comes very far short of distinctness. Now, with regard to the special subject which Captain Bolton has treated of to-night, *i. e.*, flashing signals, so far as I know, the subject was first brought forward by Mr. Goldsworthy Gurney in 1839. He then called them intermitting signals. A patent was taken out for them with the Bude light. They were made in two ways: one by bubbles of oxygen gas or inflammable gas, where oxygen gas was not used, passing through water; and as it had to displace a column of water in coming up the lamp, it constantly produced intermittent signals, of course, not upon any system, but merely at a certain speed. At the same time he described a system very similar to that in use in the model lighthouse before you; that is to say, he had a revolving shade with a slit in it, which

exposed the light as it passed round, and thus flashes were made. Here again, there was no system attempted; it was merely to show the manner in which the thing could be employed. Professor Babbage was I think the next who brought forward the subject; and his system I am bound to state is extremely correct. When I took up the subject, I was not the least aware that he had done more than just touch upon it; but in the course of my experiments I was obliged to discover that he had not only touched upon it, but that he had gone very deeply into it. And as far as I know, his arrangements are the only ones brought forward for flashing signals, in which there is really a practical value. The question of flashing signals is divided into two parts—the light and the system. Upon the light I should be very sorry to touch at all, because different lights must be used for different purposes. If the lime light answers for the purposes of the army and can be used on shore, and I have no reason to doubt that it can, let us have the lime light for the army. But the lime light is perfectly inefficient for ship use. It would be quite impossible that we could have any apparatus of that sort on board ship. Another reason why the lime light would not answer for ship work is, that there must either be clock-work attached to it, or else the piece of lime itself must be at hand for manipulation. Now, neither of these conditions can be secured on board ship. We now come to the system part of the arrangement. I dare say a great many people who saw the immense rapidity with which those flashes were displayed upon the wall at the back of the theatre, thought that that speed was perfectly unattainable, and that it would be impossible to read at that speed. I can only say, having seen Captain Bolton's experiments at Aldershot, I have witnessed the signalman read the signals with the greatest ease, when the light to my own eyes, notwithstanding all the practice I have had, seemed to be flickering. With regard to the system of flashes used, Captain Bolton recommends that we use for a general system of signals, as I understood him, both for army and navy purposes, Morse's alphabet, that which is used by the electric telegraph. That is, in other words, that we should make the basis of our system, spelling. Now, to a naval officer such an idea appears absurd. It would be quite impossible to carry out any system of signals in the navy by means of spelling. I have often heard it said that the great advantages of Captain Bolton's system, or rather the great advantage is, that it does not require a code. Now, what is the disadvantage of a code? Here is the army signal book; it is not a very large book; not very difficult to carry. I really cannot see any objection to the use of it because of the difficulty of carrying it, of turning over the leaves and finding the places. Then, what are the advantages of using a code? We saw that signal transmitted, "The enemy is advancing." Now, that consists of nineteen letters. Nineteen letters must be transmitted to send that signal. It is sent by means of the army signal-book with four figures. If you use a spelling system, if you use the electric telegraph system you are obliged to cause your signalman to learn an immense number of symbols. Captain Bolton uses for his light, I think, forty-four symbols. We use in the navy forty-seven flags. Of course it would be an answer to me at once, that if we use in the navy forty-seven flags, why should we not use forty-four flashes in the same way. The answer to that is, that each flag is identical; you cannot mistake a white flag with a red border for a red flag with a white cross on it. There is no possibility of mistaking those; the moment you have learned that each flag requires its own identity in your mind, you can never confound one flag with another. But it is different in the case of flashes, because every flash is resolved into its elements—every flash is composed of a series of long and short flashes interchanged. The difficulty would be for a man to recollect what the dot and the dash is, and what the dash and the dot is. Those are points in which confusion arises. Any person who has undertaken to teach a child will very soon understand what those difficulties are. A child has no difficulty in distinguishing *a* from *b*, or *b* from *c*; but he has very great difficulty in distinguishing *b* from *d* and *p* from *q*; and when he gets on a little further, he has great difficulty in distinguishing *no* from *on*, and *say* from *as*. It is just the same with the system we have had described to-night; there is very great difficulty unless a man has constant practice in distinguishing the symbols when they are reversible; and it is impossible in using a system of flashes to avoid using those reversible symbols.

Of course, as Captain Bolton works his system, doubt may be thrown upon what

I have said, because the men that he employs to use the telegraph are kept in constant practice. I think, if I am not mistaken, that he gives each man three weeks' training, and that he considers 150 hours the proper amount of training a man should have. That being so, a man goes to work after his three weeks' training, and he is perfect. He goes away, as we say in the navy, "Tail on end;" he can work away, and astonish everybody. But try the man a month afterwards, when he has not been signalling in the meantime, and he will not be able to make a single signal. I have seen that strongly marked in the other system of signals. For instance, in Redl's cones, there are only fifteen symbols to be learned; and the memory, in learning these symbols, is assisted by a mechanical management of them. The four cones are numbered 1, 2, 3, 4, beginning at the top; then combinations of these numbers are made for the higher numbers. Well, I have found that a man will learn these in a couple of hours, and be a very good signalman at it. I have taken him away for three or four days, and he has then not been able to make a single signal. I have also tested men in using the semaphore and Redl's cones. I have found, that men coming from the Semaphore to Redl's cones have the greatest possible difficulty in using those cones; and then, when they have got used to them, and I have taken them back to the Semaphore, I have found the greatest possible difficulty in getting them to use that again. So I say we should be very careful in what we do, to have something which will not require practice; or, if we are to have something that will require practice, then we must provide the practice. Now, I say, in using Captain Bolton's system, as long as the military authorities are content to depend upon the operators, they are perfectly right. There is no question whatever they would obtain the greatest possible gain from using those operators; but if they go beyond that, I think they are wrong.

Of course I have my own plans, and I may just state what they are. I use a long and a short flash with the light. I use any light that may be required. I use the long and short flash, but I depend almost entirely upon a code. Of course every code, every system of signals that has ever been invented, provides the means of spelling; but, as a rule, it is the last thing I should think of, to make that the basis. So, in the army code and the navy code I would altogether exclude the telegraph alphabet; and I would make the signals quite independent of individual skill. The requisite number of symbols to be learned would not be more than fifteen or eighteen at the very outside. Those would give you all the signals that you might wish to make; and every signal is made quite irrespective of the skill of the operator. It is done by the turning of a handle. The instrument is set at a certain signal, and at a motion of the handle it displays that signal quite correctly, and in a manner that is impossible to be mistaken. Of course the reading of signals must depend upon skill, but we ought to provide such signals as will require the least possible amount of skill.

Mr. Goldsworthy Gurney:* As my friend has alluded to me, I may perhaps be allowed to say a few words. First, I would state that I am the inventor of the lime light, although it first took the name of the Drummond light. I should be glad to show Captain Bolton the book in my hand. I do so with an object, viz., to show that I do not come fresh to the subject. It is a subject I have had under consideration and practice for the last forty years. This book was published for me in 1823, by Whitaker, of Ivy-lane. It is a series of lectures on chemical science. The last lecture is on the best mode of applying the mixed gases in producing heat, which produces all those effects that are detailed; and amongst the rest a light; and the difference on the subject is shown. For this purpose, perhaps, you will allow me to read:—"The light from pure lime is so astonishingly intense and powerful that it cannot be borne by the eye at all, particularly when under a strong flame, from nine to ten inches in length. The light from lime is not unlike daylight in its appearance. I am confident that one of our largest theatres might be lighted with it, with the most splendid effect; in fact, every other artificial light is thrown into shade before it. However fanciful the idea may be, I cannot help thinking that at some future time the light produced in this way from some of the earths may be used with great

* Now Sir Goldsworthy Gurney.—Ed.

advantage in lighthouses." The light remained for four or five years unnoticed, when Lieutenant Drummond whose name has been mentioned, applied to me on the subject, wishing to use it in the trigonometrical survey. I fitted up for him an apparatus, and placed a ball of lime in the focus of a parabolic reflector. That arrangement produced a most intense and powerful penetration. It was first tried in Ireland. There was no difficulty in taking the bearings with great accuracy. It was then tried in this country from hill to hill. The same instrument was taken to Loch Nayed, in Ireland, and shown across the Channel; and it was seen at Ben Lomond. Sir John Burgoyne was present, and saw the experiment. The distance was ninety-five miles, and the light was seen distinctly; but during the experiment an accidental touch on the parabola threw the focus out of the spot where the viewers were, and they never could obtain it again, so it was only for a minute they saw the light.

This light was called the Drummond light. A Committee of the House of Commons sat in 1832. Lieutenant Drummond was examined on that committee, and gave very long and interesting evidence upon it. He said his name had been attached to it, but he had no claim to it. He wrote to Mr. Hume, who was chairman of the committee, to state that he had no claim to the invention of the light, but that he had it from Mr. Gurney in 1826; and that in 1823 he had witnessed the presentation of the gold medal of the Society of Arts to Mr. Gurney. That medal I have in my possession, as evidence that the light was introduced forty years ago. I have also the letter of Lieutenant Drummond to Mr. Hume. Lieutenant Drummond claimed the application of it to surveying purposes, but not the invention. I have read that as evidence to show that I have given attention to the subject The book did not reach a second edition, though all the copies of the first edition were sold. The question was raised as to whether, in some points, we were not going rather too far. In one of the lectures reference was made to the revolution of bodies by electricity, and it was said by some of the reviewers that I might be considered theoretical; therefore the book was never afterwards re-published. This light was used by me in the Trinity House. We made a great number of experiments there, and we found that the unsteadiness of the light, the want of divergence, for there was no divergence with it, prevented it being used for lighthouse purposes. Then it was I constructed the Bude light. It was a light applying oxygen to the interior of the flame. That light was used, and was introduced into the House of Commons, as a means of lighting the house. At this moment I have in my possession a light which is just finished, which I think appears to be of more value than all the rest put together. I told the Lords of the Admiralty that I had wiped my hands of all intense lights, and had introduced this, which was on Saturday shown at the Royal Society, and the apparatus was used by the Prince of Wales. The light was admitted by everybody to be quite equal for anything practically required. The code of signals is very simple, and, if it be considered of interest to this institution, I should be happy to show the light, and show the code of signals attached to it.

Commander Fremantle, R.N.: Having been flag-lieutenant in the channel fleet for more than two years and three months, I may state that we have had a great many things sent down to us to try. Of all the lights we have had, Mr. Ward's light and Mrs. Coston's light were the most beautiful. Mrs. Coston's light—a pyrotechnic light, lit like a port fire, and had a very pretty effect. You could see it ten miles off. Several kinds of lights and many flags were tried. Mr. Ward's and Mrs. Coston's were certainly the best. They both depended upon colour. I do not think so much of colour-blindness as Captain Bolton does. I was very much disposed to support Mrs. Coston's light, but like the others it is open to several objections. I think there are three things required in the transmission of light signals. You want simplicity, portability, and speed. I may be allowed to say that Captain Bolton has succeeded, as far as it is possible with a lime light, in having portability. In speed there is no doubt he has succeeded. I think a great deal too much so. The speed with which those messages were transmitted was too great for anybody to read them without a great deal of practice; and, as I heard my friend Lieutenant Colomb say, it takes a man three weeks to learn the code. As a signal officer, I beg leave to say, that in my opinion I consider that a great deal too long to learn any code of

signals. In consequence of that, thinking there was too much complication in all these flashing signals, and that it would be too difficult to introduce anything of the sort, I had myself fixed upon colour. If you only have red and white, which of course you must have, and leave out the green, I believe there is very little liability to mistake. Colour-blindness is a new invention, I was going to say, at least we only heard of it sometime ago. I believe people run mad upon the subject. I never met with colour-blind men myself, therefore I think there are very few of them; and if you have practised men (of course I do not mean to say there is no such thing as colour-blindness)—but with practised men I believe you would not find it interfere very much. However, I have seen lately a system of flashes which is slower than Captain Bolton's, but still it is quite fast enough for our purpose, and I shall pin my faith to that, until I hear of something better. I hope Lieutenant Colomb will give us some account of his system on some future occasion. But returning to my point about simplicity; with regard to what Captain Bolton told us, I think there are very few intelligent captains—(I believe that is the phrase which he made use of)—when it comes to a question of signals, who know one flag from another. It takes a long time for any merchant skipper to learn any code of signals. They have got Marryat's, which is a very poor one; but they will not accept a new one, which is very much better than Marryat's in every way. Therefore, with respect to the system which Captain Bolton has proposed to introduce of numbering lighthouses, I myself would rather stick to a red light, and believe in a red light, a revolving light, which anybody can understand. A skipper looks at a revolving light and says, "I understand that." A flash light—"I understand that." He knows where he is; he can find the lighthouse with the red light on the chart; but as for his learning to read 254 or 176, he will never learn it.

Mr. Babbage, F.R.S: Perhaps the best thing I can do is to point out some things that may be useful. The part I have taken in questions of this kind is pretty well known in this and in most countries. I have not had the practice which some gentlemen who have spoken seem to have had. But as the result of observation and inquiry, it seems to me that there is a great deal in the numerical system if it is clearly defined, such as an ordinary person can comprehend. It is a thing we are accustomed to. Again, I believe we have in most services, sets of questions—I do not know the technical term—numerically arranged. Take, for instance, things relating to commerce; there is a dictionary of ten thousand terms. Again, there is a dictionary of the names of persons, similarly arranged. I recollect when on board an Indiaman being very much surprised in this respect. We met a vessel coming from India, and a friend of mine said, "We will ask who is on board?" "Ask who is on board!" I said; "how will they tell you the names of people?" He replied, "I have got in my signal-book every name; I daresay I have got yours. They are numerically arranged in this signal-book." There is a dictionary of names, a dictionary of places, a dictionary of nautical things, a dictionary of military things, and so on. All these are marked with the same numbers. You first signalise the dictionary, and then the number: that makes it exceedingly easy if you have got a good mode of giving the number. Now the great objection to coloured lights, besides want of simplicity, and more than want of simplicity, is that you lose light; you cannot see the red light at the same distance that you can a white light. It is a difficulty, and it must always be a difficulty. Names have been used, but I am not quite sure that we all understand the same thing by the same name. There is a difference between flashing and revolving. We know that flashing is quicker than revolving. They are both occulting. What I have called occulting is a much quicker mode; you can easily occult either horizontally or vertically. Let me point out some of the conveniences where a system of numerals is employed in lighthouses. I believe you may light a thousand miles of coast and yet not go beyond the number 9, and still it shall be impossible to mistake one lighthouse for another. If you occult very suddenly, it is astonishing the quickness with which the eye catches it. You may have occultation with what I call "a blink," which occupies very much less time, at least much less than two occultations. You may by that means again shorten your system of signals. But I believe, so far as I have examined the question, that numerical signals are to be preferred, if made in the simplest way that you can make them. There is

another advantage in the system, which I suggested to the United States. I exhibited it at my own house in the year 1851. I have been looking at the question for years, to see what products of illumination would enable me to illuminate with intense light the interior of my house without having a light in it. I attended every public place I could where there was a great and splendid light, but I always came away with the conviction that it was a beautiful light, but not fit for my purpose. For the use of the eye, nothing is more absolutely necessary than a perfect steadiness of light. Now, I have particularly applied myself through life to this, to find out how it is that men pass from what all our race know to get something new? How is it we invent? It is an immense question. I have always studied it; and one of the laws that I have laid down is this:—When you make an experiment, and you find something goes wrong, your first object clearly is to see how you can remedy that defect, and set it right. But, after you have done that, there is another and very important thing for the progress of knowledge. That which was a wrong, an injury, and a disadvantage for your purpose, may be eminently useful for something else. Now, as I said, I went away from many of these places, saying, "Well, that is a beautiful light! but it flickers; it is not steady; sometimes it goes out." I recollect on one occasion walking away from one of these lights, regretting that the beautiful thing could not be made available for homely purposes. Then occurred to me my rule:—When you find a defect, go and see whether you cannot find a subject in which that will be an excellence. It immediately occurred to me—"Dear me, break the electric contact, and you have got a breach of continuity of light; put it on again, and you then get number, if you like." "Well," I said, as I walked on, "what a capital thing that would be for lighthouses, to make every lighthouse give its own number." Then, it occurred to me, "But why use the electric light? why not pass a shade over it, or before it?" Now, I believe, practically, if we take lighthouses, and call them 1, 2, 3, and so on, that we should not want more than nine figures. You might carry the system further; but with this limit I could show the means of lighting a thousand miles of coast, without one light resembling the other, or being mistaken at all for the other. Having done this, I thought I would make a little lighthouse. I took a lamp, on a very small scale, and I put it in the upper window of my house, which looks down into Manchester-square from Dorset-street. It was during the Exhibition of 1851. The first night I put it up, and left it, making its signal a number numerically. I walked away, with my back to it, and when I got half-way down the street I looked, and I saw 33 or 35, or whatever it was. Thirty-five, I thought, went very well, but there was a kind of hitch in it. The fact was, there was a little hole in the lamp, and there was a shade that went before it, which would make an occultation, or little interruption; but that shade fell down, or something jumped up, and half occulted it. The consequence was, as I looked at this, the 3 was on occultation, with a kind of blink; 1, the same occultation, with blink; 2, the same with blink 3. I said to myself, "That will do very well; I can easily alter that; something is too elastic below it." I again turned my back to the light, and walked on, and got about, perhaps, half a quarter of a mile. I now went down to the end of the square, not having looked at my light. I turned round, and I said, "Dear, me; why, there is no blink; it is regularly 33," or whatever the number was. There was not the slightest twinkle. I said, "What can this mean; can one of my workmen have gone and seen the defect, and altered it?" So I walked up, looking at the number; the number perfect, but the blink not there. As I approached it, I said, "There's a little blink;" and, when I got back to the place where I was before, there was exactly the same thing. I was strangely puzzled. "What is the meaning of this? This blink I could make use of; it is a valuable thing; but I should like to know what is the cause of it." The cause (here was the defect, mind) was this: I made a very small hole in the dark shade of my lamp; so small, indeed, that if I could have got further off, I should not, perhaps, have seen the light beyond Manchester-square. But the fact turned out to be this: that I had got a hole that would, with that light, exactly enable me to see it at half a mile. The shade that went over it, and covered it, gave the occultation: it jumped up, and covered half of it. Now, when you had only got the half-

light, you could see it at only half the distance. That was the reason, as I got to the end of my distance, that I saw the whole occultation; but I did not see any light when there was only half the distance; there was not light enough to penetrate. Again, I applied the same principle: "When you have got a defect, can't you make use of it?" Well, I said; that being the case, we can make use of it in this way. If your lighthouse can be seen, say thirty miles off, it would be a very important thing when you look at it that you should be able to say you were within ten or within twenty miles of it; and you could do that by making two blinks. By cutting off one-third of the light you would see at two-thirds the distance, and by cutting off two-thirds of the light you would see at one-third the distance. Suppose the whole light to be seen at thirty miles, two-thirds would be seen at twenty miles, and one-third the light at ten miles. So here was the use of a common-sense rule—turn that which is an evil, and see whether it is not an advantage for something else. That was the result of following out that principle. I just mention these things, and throw them out for consideration, because I myself have no time to work them out. I have laid down the principles, and it must be for others to work them out; but they are matters of considerable importance. Of course, to be able from a lighthouse to direct into port a ship that has got no pilot, would be a very desirable thing; and with such signals as these you might do it. But there are certain other uses to which this system might be applied. There is now in contemplation, and it is very desirable, to have Greenwich time conveyed to the most distant points of the Channel, so that ships would be able to see it in passing; a plan for firing a gun at one o'clock (I think it is), at the Start; to fire the gun by electricity, and thus give the correct time. Now, if you have an occulting light, you can give the time as often as you will by night. Then, there is another mode of using the light by day, which I think is very useful; perhaps more so to the military than to the naval profession. This mode consists of communicating by occultations, what I have called, a zenith light. It is nothing more than this: You take a large inclined mirror, or looking glass, and put before it a shade: it may have a round or a square hole, or it need not. Now, if you drop that, it will send a ray of light from the zenith; when there is no sunshine that is generally the brightest part. I find that I can see a four-inch aperture of looking glass at a quarter of a mile; therefore, it would appear that a very moderate looking glass of three or four feet could be seen at six or eight miles. This would be useful in directing a vessel into port. Now, if you were to have a large mirror at the Start, you could note Greenwich time every five minutes to passing vessels, just as with the light signals you could communicate it at night. I mention these things, because the wants I have indicated, are so great, that at some time or other the application of these useful things must come, and because stating these points will accelerate the labours of those who are endeavouring to work them out now, and it is desirable for them to know that they may be working for even a greater purpose than perhaps they suppose.*

Captain Bolton: I just wish to make one remark to clear myself from the imputation which I think Mr. Gurney threw upon me; that is, that I had claimed to myself the invention of the lime light. If you remember, I said in my lecture that the light that I have chosen to serve as a telegraph light for field and army purposes generally is the lime light, or, more properly speaking, the oxy-hydrogen light. I am afraid from the way in which Mr. Gurney spoke of me, that he thought I claimed the invention of the lime light. I was only showing how it could be utilised.

Mr. Goldsworthy Gurney: No, I do not do that; and this I can say in addition, that I do not suppose there are a hundred people who know anything about the lime light. I should like Mr. Babbage to see a series of numbers which I have, that can be seen at a distance of fifty or a hundred miles. It will show that the plan can be carried out practically.

* On account of severe physical suffering, both Sir Goldsworthy Gurney and Mr. Babbage were unable to correct the notes of their remarks as carefully as they would otherwise have done.—Ed.

Mr. BABBAGE: Reference has been made to the lime light having been seen at 95 miles. There is another light that was seen at 108 miles, in connection with the system of numerical signals, that I devised many years ago. I happened to be in Paris. I was illustrating the use of these discoveries, and I said, "If there is a place in the neighbourhood of Orleans" (which is just about a hundred miles from Paris) "from which you can see any place in Paris, then, even though the whole intervening space were occupied by the enemy's army, you might under certain circumstances—I do not say all—most probably every day you might have an opportunity of communicating between Orleans and Paris, without anybody, not only not being able to prevent you, but without even knowing it." It could be done without electricity, by this means. In the Irish survey that was referred to, there was a triangle formed by a mountain in Scotland or Wales connected with a mountain in Ireland, 108 miles distant. They had a looking glass, and they directed the sun's rays to it. The weather was foggy and cloudy at the time, and they had considerable difficulty in getting a favourable opportunity. It cost them, I think, a fortnight's encampment upon the mountain. I apprehend they had a small looking.glass, not above a foot square. But if they had had sunshine, then they might with a very small mirror have obtained the angle of this base of 108 miles; and, instead of waiting two or three weeks, they would very soon have got the angle, because it would have been so much more easily seen. Now, if my system of numerical occulations had been applied, it would have been a telegraph. I mentioned the above circumstance some years ago. I think at Brussels there was a meeting of the naval men of all countries, a kind of congress. I had my occulting light there, and I afterwards went on to Paris, and I mentioned the subject there. Since that time I have seen in the transactions of the Institute, that in the southern part of Algeria, during eight months of the year, when they have sunshine and very little cloud, they have established a very simple system of telegraphy. They had a looking-glass, a very simple apparatus, and they made these signals numerically. During those eight months of the year they signalised over 800 miles. It is very desirable to point out that with the sun (although we cannot always command its rays, yet there are times when we can afford to wait for it), we could get angles at distances that we are not able to get without.

Mr. GOLDSWORTHY GURNEY: These experiments were recorded in the *Philosophical Transactions* of 1826. They were made by Lieutenant Drummond, Captain Colby, and other gentlemen, with the heliotrope. They reflected on a tin plate, and they saw at that distance; then they used the mirror to see further. The Bude light was seen at a distance of 108 miles in the Pyrenees.

LECTURE.

Friday, May 8, 1863.

COLONEL P. J. YORKE, F.R.S., in the Chair.

THE RECENT CAMPAIGNS IN VIRGINIA AND MARYLAND.

By CAPTAIN C. C. CHESNEY, R.E., Professor of Military History, Royal Military College, Sandhurst.

I DO not desire to take this opportunity of introducing into the narrative which I am about to give you any part of the military discussion of how much of soldiering may be learned by the mere study of books; but I would preface what I have to say by just remarking that I think it is simply impossible for any one to study to advantage, any campaign of importance without taking into some consideration what are called the general principles of war.

They are not so difficult to understand. The fact that a modern army of any size cannot possibly enter into an enemy's country without taking with it large supplies, and also without having those supplies constantly replenished from some great depôt called a base, which it leaves behind, and that, in consequence of that necessity, the general commanding is obliged to have a line of communication always open—never interrupted by the enemy—between himself and that base. The fact, again, that though two or three small armies cannot be expected long to resist two or three large armies, yet if the two or three small armies combine together, theymight successfully attack and beat each of the other and larger armies. The fact that, though a single small army cannot be expected long to defend any place against a very much larger one advancing against it, so long as that large army holds itself together; yet, if divided, the larger may be attacked and beaten in detail, as has happened a thousand times in warfare. These three main facts—all simple enough when explained in them-

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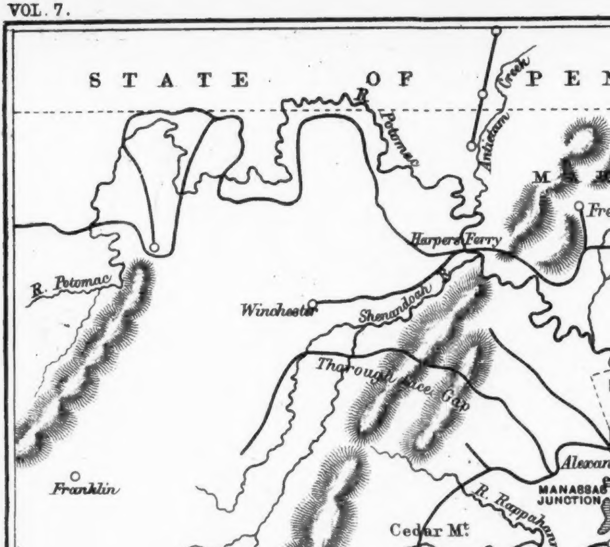
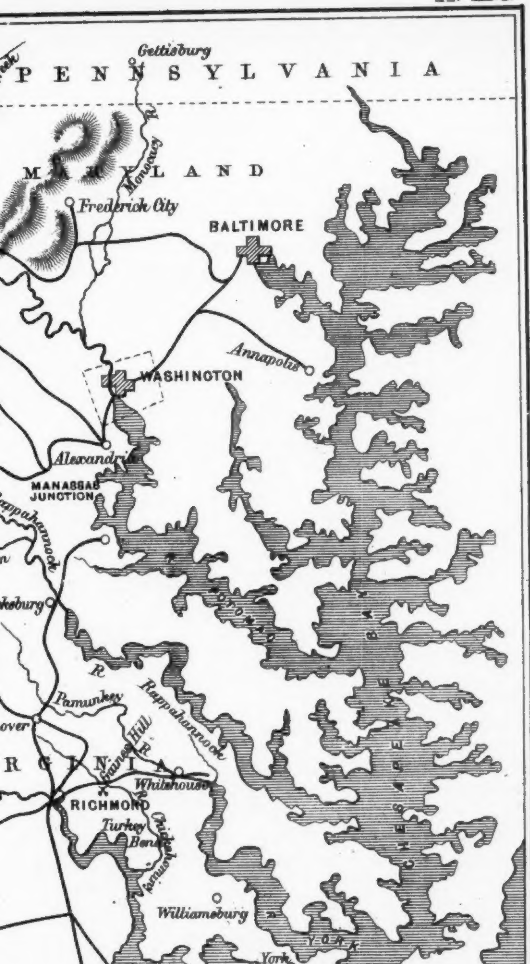


GENERAL SKETCH
OF THE SCENE OF
M^c CLELLAN'S AND POPE'S
Operations in 1862.

Scale of Statute Miles.

0 5 10 20 30 40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PENNSYLVANIA
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Frederick City
BALTIMORE
Annapolis
WASHINGTON
Alexandria
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POTOMAC
BAY
CHESAPEAKE
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Pamunkey
Gaines Hill
R.
Whitehouse
RICHMOND
Turkey Bend
Chickahominy
Williamsburg
YORK
York town
JAMES
Fort Munroe
Norfolk
PE'S
RTH CAROLINA

J.R.Johkins

selves—give rise to certain rules; and, according to those rules, in some measure, campaigns must be weighed and tried. There are other circumstances, of course, to be considered; but, unless people think a little of these things, they cannot expect to read with profit or interest the account of any great campaign.

Now, these campaigns in America are no exception to the ordinary rules of warfare. These same rules that I spoke of, flowing from the facts I have just mentioned, have been somewhat hardly treated. Some people have written of them in such very high and dry terms, that they make the world believe that they are almost impossible to be understood. Others, knowing that mere reading alone cannot make a soldier, take it for granted that no reading or study can be of use to make a soldier. They take the opposite extreme. I say we must take those same facts and rules into view in speaking of the recent campaign in Virginia.

Before I speak of the facts that have occurred during the last year, I must ask you to look at the map of the country. Last year, Major Miller gave an able lecture in this Institution on the origin and the beginning of the American War. He carried it up to a certain point, and there he left it. In speaking of the tract of country before you, he spoke of the advance of the Northern army, which ended in the defeat and disaster known as the battle of Bull's Run. I wish to-day to discard all other parts of America except that portion of the state of Virginia on which that campaign took place; and of that alone I shall speak. That great and historical State—the most historical of all the United States—is divided nearly in two by a large back-bone of mountain, wide and high, called generally the Alleghany Mountains. The western side of the State, which lies out of this map, we have very little to do with. It is understood to be chiefly northern in its sentiment, and to be as divided in opinion from the eastern part of Virginia as it is by the fact that these high mountains are between the two. But when you speak of Eastern and Western Virginia, you do not take in the whole State, because it happens that the Alleghanies are broken into two great ridges, known as the Alleghany Ridge and the Blue Ridge; and between these two ridges lies a long and very fertile valley—the Valley of Shenandoah, so called from the river that drains it, and with which valley we are to-day somewhat concerned. That valley, like Eastern Virginia, is more inclined, in general sentiment, to the South than to the North; in fact, it is Southern, wherever it is free to choose.

You see on the map the capital of Washington, and opposite to it the hostile capital of Richmond, about 150 miles being the distance between the two. The river Potomac, descending from the higher parts of the Alleghany Mountains in its course, divides Virginia from Maryland, which lies to the north. Parallel to the Potomac, a number of small streams descend from the Blue Mountains, and run into the same great estuary—the Chesapeke—the chief among them being the now historical Bull's-run River. Next is the Rappahannock—a large stream that flows by the old town of Fredericksburgh. Next is the James River, which passes by Richmond, and is navigable up to that

capital. Parallel, however, to the James River, at its mouth, is a sort of embouchure of salt-water, into which two or three small rivers flow. It is known as the York River. Between that and the James River lies a long, narrow peninsula, some fifty miles long, about twenty miles wide in some parts, and much less in others, of which I must ask you to notice the general figure before I come to the account of the campaign.

In European warfare, armies moving into an enemy's country have to consider chiefly—at least they have had to consider hitherto—the main roads, the *chaussées*, paved or macadamised usually in these days—of the countries that they are about to enter. But this particular warfare in America is quite an exception to any rule of that kind. The roads are so bad, (being mere country tracks, without any surface,) that all communication by them for the supply of a large army must be abandoned, as the principle on which approach to the enemy is to be conducted. From the very first, the Northern Generals knew perfectly well that whenever they advanced towards Richmond—the object that was then before them—they would have to depend, not upon the roads, but upon the railroads. And even with respect to the railroads I should notice how very rough they are compared with our own; generally a single line of rails, with sidings here and there for the trains to pass each other, and with a great deal of wood work used in the construction of them, which, of course is not very lasting. Of these railroads, the chief one in connection with this campaign—the chief communication of an army going straight from Washington to Richmond—is the Orange and Alexandria railroad, which runs through the field of Bull's Run, going on to a place called Gordonsville, where it meets a great railroad coming from the west, which brings it round by a turn into Richmond, at the north. That is one of the main approaches in time of peace, evidently, from Washington to Richmond.

There is another way of getting from Washington to Richmond; descending by steamer a few miles down the river Potomac, and taking the railroad from Acquia creek, due south, into Richmond. Both these ways have been tried, as we most of us know, in the campaign that is just passed. There are various approaches to Richmond from the south by railroad, as well as by the James River, when it is open; but these do not so particularly concern us. The valley of Shenandoah is again entered by railroads; one, which is very remarkable as an engineering work, passes right over the Blue Ridge Mountains—among which is the little mountain called the Bull Run Mountain—and descends by a series of steep inclines into the valley. That is one way of getting from Washington into the very heart of the Shenandoah Valley. Another way is to go by the railroad which leads westward from Baltimore, and runs up the Potomac; and leaving the Potomac at Harper's Ferry, to go up the valley to Winchester, which may be considered the capital of the northern part of the valley.

Understanding, then, that these railroads, or else that water communication must be the means by which an army should go—as the Northern army had to go, if they could—to get to Richmond, I proceed to speak more particularly of the facts, as they have been lately enacted.

In the month of March last, you find around Washington and Alexandria, a town on the other bank of the Potomac, so near that it might almost be called a suburb, a large army of rapidly levied battalions. They were not an army in the strict sense of the term, as we call an army, that is, composed of trained soldiers. But they were men who were at that time ready to fight, and generally composed of volunteer regiments hastily raised; very improperly raised, as most other people but the Americans think—as far as giving commissions to the officers—by private interest, the private interest of petty people in the different states. But still, they were brought together by an outburst of enthusiasm; and as the effect of the disaster of Bull's Run in the year 1862 had passed by—(that happened in July and we are now speaking of March in the following year)—it was hoped that they would do something great for the state they served. General M'Clellan commanded them, a general who had been brought into this high charge almost immediately after the disaster of Bull's Run. The unfortunate man M'Dowell, who was then in command of the Northern army, had been removed. He had been superseded immediately afterwards, not because the President considered he had any cause of complaint against him, but merely because the people required a new general; and M'Clellan who had had some trifling successes on the other side of the Alleghanies, which had gained him a reputation as a skilful soldier, was brought over and placed in command. A very happy choice the Northern Cabinet seemed in that respect to have made when they chose M'Clellan. Not that he has showed in the field any striking capabilities; but some capabilities for a general he certainly has; for I am told by those who have been with him for many months, that he has attracted the confidence, I may say the love, of his soldiers in a remarkable degree; and as we all know that is one quality which goes towards making a perfect general. M'Clellan seems to have that quality in a very high degree. Moreover, he seems to have been a man who made use of the opportunities he had derived from the high military training which he obtained at the celebrated military school of West Point, and from having watched the operation and administration of our armies in the Crimea some years before, he was well qualified to apply his theoretical knowledge in the practical school of a campaign

Now, the problem before M'Clellan last March, with his large army, alleged to be (the number has been variously estimated) from 150,000 to 200,000 men, but amounting, probably, to 130,000 men, and encamped round Washington, was, "How to get to Richmond?" In order to do so, he had been many months carefully engaged in making round Washington and Alexandria a very strong series of works. Copying in some degree the example of the great Duke of Wellington, who in the Peninsular War obtained part of his success by reason of the strong fortified base that he had in the mountains above Lisbon, so M'Clellan had not lost his time during the winter; but, while he was drilling and bringing into order the volunteer troops under his hands, he had been also employed in running up that line of works. The reason for which will appear presently; for

his plan was not to go direct south to Richmond, but to go round by sea. Considering the 150 miles which lay between Washington and Richmond, and the fact that in moving direct by land he could have but one line of railroad to supply his large army, and that that railroad would be inadequate for the purpose wanted,—being a single line of rails, it would be inadequate to bring from day to day the immense supplies that the Northern armies seem to require,—and also having before him the fear of a dash made by the enemy on his rear, as a move which might break up the railroad and stop the supplies, he determined to try a safer way of getting to Richmond. Having his eye on the peninsula between the York River and the James River, he was aware that at the extremity of this peninsula was a fortress in the Northern hands, Fort Monroe; and he determined to move his army by sea to that fort, and then move his army from that point by land to Richmond; or the steamers would take him up the James River until he came to the city itself. If that river was stopped, he had another way of getting there, because from the York River, a short railroad of only about thirty miles in length, from the point where he could bring his steamers, led straight to Richmond. He might work his army up to that point, and there, by this short line of railroad, force his way on to Richmond.

But, in order to execute this plan successfully, it was necessary not only to lay out a plan beforehand, but to endeavour to keep the Southern army as near Washington as possible. Until nearly the end of 1861, the Southern army, which had been victorious at Bull's Run, and which had been afterwards increased by reinforcements, was lying very close to Washington and Alexandria. Towards the end of that year, finding it exceedingly difficult to get his men supplied at so great a distance from home, the Southern General, Joseph Johnston, withdrew his troops back to the old ground which they had occupied some months before the battle of Bull's Run, the ground above Manassas Junction; and here he was lying at the time I am speaking of—in the middle of March. M'Clellan, having his plan laid out beforehand, had determined, if possible, without alarming the Southern General, to move the whole of his army at once by sea, or as many men as he could get transports for, to Fort Monroe, and thence march straight to Richmond. He hoped, not unnaturally, that as the Southern army when they heard of his movements, would have to march the whole distance from Manassas Junction to Richmond, he should be able to get to Richmond before the body of General Johnston's army could do so. He was disappointed in this, apparently by treachery. A council of war being held, in which his plan was to be discussed, in the presence of the President and the principal Ministers, he was obliged to say plainly what he intended to do; and, within a few hours afterwards, the whole of the facts were known to the Southern Generals, who were lying about twenty-five miles from him.

In consequence of this betrayal of the design, which happened at the beginning of March, the Southern General, knowing what was to be done, broke up his camp and moved southwards at once, in order to protect his own capital. M'Clellan's plan was exposed; and, making a

slight attempt, as he did in a hurried manner, to pursue his enemy direct southwards, he soon discovered that his own imagination had not by any means overrated the difficulties of moving an army through that country; in fact, that they were very much worse than he had supposed, and that to follow the Southerners that long distance to Richmond overland, was too troublesome a business to be followed up with an army of 100,000 indifferently-trained soldiers. He therefore resolved to carry out the plan which he had first devised, although it was known to the enemy. But at this particular moment, when he was in some doubt as to what he would do, suffering the bitter mortification of having his design exposed, the support which he had had for the last six months from the Northern Government was taken away from him. Whether it was in consequence of the bitterness of the Northern press, or through the intrigues of political opponents, jealous of the power placed in his hands, the Washington Cabinet stripped him of the command of the whole of the United States' armies, and gave him the charge of this particular army with which he designed to act. Of course, he could not carry out his plans with the same vigour and hope of success as when he had the whole of the Northern forces at his disposal. In addition to this, his army was already divided into four divisions, upon a system he had set out for himself. The army was now placed in what is called *corps*,—four corps; a corps being a very large division of a very large army, containing about 25,000 or 30,000 men each. A good arrangement in itself, copied from Napoleon; but a very bad arrangement for M'Clellan, because the generals to command these corps were appointed without consulting him as to their ability, or their feelings towards himself.

But without making too much of these difficulties, he prepared to execute his plan with an army composed of four *corps* of about 30,000 men each, and moved by sea. The transports having been collected in the Potomac, he proceeded on his way, and landed safely enough at Fort Monroe. About the 3rd of April, we find him there, disembarking with three out of the four corps, and marching up the peninsula. Two days' march from Fort Monroe brought him with about 80,000 or 90,000 men, but with the heads of the columns stretched out very far from the rear,—to a place called York Town, a place well known in the former history of America; for it is the very spot where one good general—and probably the only good general we had in the old American war—with an English army fighting against Americans, was enclosed both by land and sea by an immensely superior force of foes. There is no more melancholy reading in military history than the correspondence of Lord Cornwallis, when he was shut in the entrenched lines of a wretched little village which has taken the name of York Town. There shut in, and communicating with a commander-in-chief who despised, or who would not listen to his entreaties for reinforcements,—seeing the enemy gradually accumulating forces both by land and sea around him, until hope within him died out,—and knowing that when he did surrender, his principal thought would be for the safety of the loyal colonists who had taken part with him. The fate of Cornwallis shows us that

a small force, even within entrenched lines, if left without succour, cannot hold out indefinitely against a superior force. At York Town there were lines again in this war; but this time not merely a small semi-circle of lines round a village, but they were thrown across the peninsula, and looked very formidable. The peninsula is about seven miles wide. There are creeks running into the rivers on each side, the land being low and swampy; and the natural difficulties of the ground were increased by the engineering works of the Confederates, who possessed the best engineers of the old United States army. The place had a very strong look, and it was reported to be kept by about 20,000 men, the best of the Confederate army, under General Magruder, a hard-fighting and somewhat intemperate man, but, on the whole, a soldier not to be despised. The fact, I believe is, he had not 12,000 men in the lines.

M'Clellan, in the first instance, on approaching these lines, showed some of that over-caution which is the weak point in his military character. How to turn them was the next difficulty. The gunboats which accompanied M'Clellan's army were close to his right flank, and he might be supposed able to force his way up the York River. But the batteries on the York River were so strong—the fire of forty of the very heaviest guns being brought, on that extreme point, to bear across the water—and they were so effectually backed by the fire of another fort, which had been thrown up on the other side of the York River, at a place called Gloucester, that the commanders of the gunboats thought it was impossible to take them up. You might ask why M'Clellan did not use the James River, which is navigable all the way up? For the simple reason that the celebrated *Merrimac* was at that time lying there; and, as long as she lay there, so long the Northern General found himself unable to use the James River. Although she did not choose to venture out, the *Monitor* being employed to watch her, and a number of strong, wooden steam-vessels being placed opposite to where she was expected, in order to run her down—notwithstanding she was watched in that constant manner night and day, and that every kind of impediment was laid in the Channel, by which, it was supposed, she would issue out; still, the dread of her was so strong in the Northerners, that as long as she lay there, so long the advantage of that water communication up to Richmond was lost. Hence, it is said, the vessel was worth 50,000 men to the Confederates. This was no doubt true, for the dread she inspired was as effective in protecting Richmond on the side of the James River as an army of that number of men. This impediment limited M'Clellan to the York River, where gunboats could not go past the works. M'Clellan had heard beforehand of the opposition he was to expect at this particular point. He was not unaware of these lines; and probably he exaggerated the difficulty of passing them. He determined to turn them in this way. He landed with three out of four corps of his army, the three being under the command of three respectable officers of the old United States' army. The fourth corps was under the command of M'Dowell, who, the year before, had lost the battle of Bull's Run; and he was to come after the rest. He was

to land on the Gloucester side of the peninsula, and turn the defences on that side of the river. It was supposed that by doing that, the gunboats would then force their way up, and that, when they got behind the enemy's works, the enemy would abandon the works.

Now—as we learn from a French source of authority, from the work on the campaign which is supposed to have been written by the Comte de Paris and I may say also from an English source of authority, from officers who were with M'Clellan at that time, came the first interference with, and the disarrangement of, his whole plan. At this particular juncture, he heard that M'Dowell's corps was not to be sent to his army at all. The fact was, that the President, and the President's Cabinet, living at Washington, had still before them the fear of a sudden invasion by the Southern army, wholly regardless of the danger which the Southerners supposed themselves to be in at Richmond; and they imagined that they would send an army to Washington, and capture Washington, the Capitol, and perhaps the President as well. Thinking of that, and perhaps not satisfied with the arrangements that M'Clellan had made for the protection of Washington—for, when he entrenched Alexandria, it was for the purpose of protecting Washington—they insisted upon it that the whole of M'Dowell's corps should remain behind. M'Clellan remonstrated against this; and at last he succeeded in getting one out of the three divisions which composed M'Dowell's corps sent to him, the two others remaining behind. The one division that came, commanded by General Franklin, was thought too weak for the work that the whole corps were intended to do, which was to land and turn the defences on the Gloucester side of the river. Hence M'Clellan resolved to lay siege to these entrenchments and take them by sap. A single attempt was made to carry them by storm, but it failed in a lamentable manner. He then sat down to besiege the place in due form. There was his mistake; for the garrison, at first weak, had now gained strength. General Johnston, who had withdrawn from Manassas Junction upon hearing of M'Clellan's plan, had at length reached the peninsula, bringing additional troops with him. It was on the 3rd of April that M'Clellan began his march, and we find that a month elapsed before he was ready to push an attack on the Southern entrenchments. Then he pushed the attack so hard, that the Southerners thought themselves in danger; and when they did find themselves in danger, they did not wait for the entrenchments to be taken; they did not wait for the Northern army to come in and follow them; but quietly moving off in the night, and taking with them guns, stores and everything, they abandoned the whole entrenchment and fell back towards Richmond. M'Clellan followed them up, of course. There is a place called Williamsburg, a day's march from York Town; where again the peninsula is very narrow. There also the Southerners had thrown up works intended to detain the Northerners for a certain time before it, but they failed. An action took place on the arrival of M'Clellan's troops, as soon as they gathered in front of the enemy's works. General Sumner, the oldest officer in the Northern army, who commanded one of the corps of General M'Clellan's army, commenced an attack upon

the enemy's works. By a very gallant action, one that bears examination well, a Northern brigade, by wading through an unguarded passage of one of the creeks which covered the front of the enemy's works, gained and occupied the ground on the other side, where M'Clellan soon supported them by more troops. The works were thus turned. There happened to be some open ground on their right which had merely a creek in front of it; this creek having been waded through, and these troops having established themselves on the other side, the strength of the works was gone; and if the Confederates had waited another day, they would have been attacked to great disadvantage.

The Southerners then moved right off to Richmond. That was about the 5th of May. And then M'Clellan, having now no more obstacles between himself and Richmond, commenced his original plan, which was to bring his troops to the very walls of Richmond; but never to leave either the water, or else the railroad from the water, which supplied his troops. He marched on slowly up the York river, and slowly also up the Pamunkey, a small stream which flows into the York river, but which his gunboats could get up. He reached a point on the Pamunkey where the gunboats could get no higher; but it is the same point, Whitehouse, where the railroad leaves that river, and runs straight to Richmond. He was now only thirty miles from his prey. It was now the middle of May. As he advanced slowly onwards, the Southerners seeing the time was coming for them to fight hard for their capital, began to draw in their troops from different points. They had an army of about 20,000 men down in North Carolina, watching an army of Northerners; another force was still further to the south employed on similar duty: these were brought in. The Norfolk Navy-yard which they had in their hands, with a large garrison, was blown up and abandoned, and the troops all withdrawn into the lines of Richmond, became part of the army that defended that capital. M'Clellan received few or no reinforcements. Repairing the railroad as he went, he proceeded very slowly, and passing a little stream called the Chickahominy, which just divides the railroad half-way between his starting point and the city, he got within ten miles of it by the end of May. At this time, as Norfolk had been abandoned and the troops withdrawn, the *Merrimac* was blown up and abandoned too. The *Merrimac* being gone, it was evident that nothing prevented M'Clellan's steamers coming up and supplying him, if he liked. But as he had got so far towards Richmond from York Town, he kept to the source of supply he had hitherto used, the York River and the railroad, and pressed his way by the railroad. Moreover, he looked not to the left for support, on the side of the James River, but to the north, towards Fredericksburg, which was occupied by M'Dowell, who had been left behind with the greater portion of his troops, and who had also received some additional reinforcements. General M'Dowell had occupied Fredericksburg, and he had pushed forward a detachment of his troops to within twenty miles of M'Clellan's outposts, so that if the two bodies could have been united into one army, M'Clellan could have made a formidable attack on the enemy. This was not to be.

Now came the second grand interference with M'Clellan's plans. At this particular juncture of the campaign, when he was trying to communicate with General M'Dowell, whom he supposed to be at Fredericksburg, M'Dowell was withdrawn. Before he was withdrawn, M'Clellan obtained his first, almost his only success, in what is called his peninsular campaign. You see a place called Hanover, about twenty miles north of Richmond. It is on the railroad, and commands the two railroads which lead into Richmond. On that place he made an attack on the 27th of May. He detached General Porter, who first came into notice in this campaign, a friend of his, and in whom he had great confidence, with some divisions of infantry and cavalry, in the direction of Hanover, and ordered him to take possession of the railroad. He did so most successfully; the Southerners were decidedly beaten, and Porter occupied the place. He was sent against Hanover Court-house, and he consequently came within twenty miles of the nearest point where M'Dowell's troops should be. Then it was that M'Dowell was found to be withdrawn. The telegraph first brought news that his army had left Fredericksburg, and gone back towards Washington. We shall see why presently. M'Clellan was left alone to his own devices with about 100,000 men—he had received some few reinforcements—to make the best of his way to Richmond. His army was advancing slowly up both banks of the Chickahominy, a little stream —little in point of size, but very difficult to cross, having muddy banks. As one wing of the army was on the northern bank and the other on the southern, they were for a time in a position that was dangerous to them, for the bridges that were ordered to be constructed to keep up the communication between the two wings were not made for many days; and, during the time they were being made, the first battle between the two armies took place. The Confederate General Johnston, seeing that the wing on the one bank could not communicate with the wing on the other, and that it was without any support, attacked that wing with nearly the whole of his troops. This was called the battle of Fair Oaks. The Southerners were partly successful: they drove the troops down the peninsula, and partly succeeded in their object, which was to divide the two wings of M'Clellan's army. At that particular time Johnston was badly wounded, and had to be carried off the field. At the same time General Sumner, who is now dead, and who must be allowed to be, at the very least, a very respectable old soldier, and who had taken pains to build a bridge near where his *corps* was stationed, came across with two divisions, and took part in the battle. He made a flank attack on the Southern army, and by this movement—for moving on their flank seems to be disastrous to American armies, owing to their want of discipline—the Southerners, who, up to this moment had been victorious, were thrown into disorder, and yielded their ground. The battle of Fair Oaks ended indecisively. It was characteristic of the Northern press, that they found fault with General Sumner that he did not cross before, save the whole army, and win a complete victory.

This was the beginning of June. We will leave M'Clellan there for a short time, and I will tell you why he did not get any help from

M'Dowell's troops, or from any of the 80,000 men who were scattered round Washington. General Jackson, (whose character I need not go into particularly, all of you being aware that he is a very remarkable man in the strict sense of the word), was quartered in the Shenandoah valley with about fifteen or twenty thousand men. Opposite to him was a Northern army entering the valley from Harper's Ferry under General Banks; another army, under General Fremont, on the west side; and another army, just on the east side of Manassas Gap, under General Siegel. General Jackson, descending the valley rapidly, first encountered the heads of General Fremont's column near this point. I do not pretend to go through the details of this action; suffice it to say, he had retreated rapidly for a day or two, until he had drawn the head of Fremont's army away from the main body, and then he fell on that and defeated it. The two Generals, Milroy and Shenck, were beaten, and fell back on Fremont; and Fremont, who had just sent off despatches to Washington announcing a victory, was very glad to get over the mountains and make his escape. He was disposed of for a few days. Jackson proceeded down the valley, and moving rapidly on Manassas Gap, fell on a detachment of General Banks's troops, and defeated them. General Banks, who was down at Winchester, hearing of what had happened—(he of all the civilian generals that have been raised in the whole war seems to have shown the most ability)—came up speedily, and tried to support his unfortunate detachment. He met with Jackson under disadvantageous circumstances, and was beaten on the two days following, the 24th and 25th of May, and was driven right over the Potomac into Washington.

A panic followed. No sooner was he over the river than the Washington Cabinet thought Jackson would be in that city. In their fright they called for more troops. They sent for M'Dowell, and collected nearly 80,000 men round Washington, who were all neutralised in reality by Jackson, with his little body of 15,000 or 20,000 men. That was the reason why M'Dowell did not go on from Fredericksburg to join M'Clellan. The Northerners expected that Jackson would be reinforced, and make an advance on Washington. The Southern authorities had no intention of doing anything of that kind. Their intention was, that Jackson should be brought back to take part in some decisive operations before Richmond. Before he could get back, as he was on his way up the valley, he had a second time to encounter Fremont, who had made his way a second time into the valley, at a place called Cross-Keys, a village near the little town of Franklin. An action took place between Jackson's troops and Fremont's. Fremont again wrote off to Washington, again reported a victory, but victory was not so easily achieved. His troops, however remained standing, and Jackson's moved off, without such a thing being in the least suspected by either of the armies that he had confronted there.

While these things were going on, nearly all the month of June passed away in front of Richmond in perfect inaction. The time came when Jackson knew that the troops he commanded should be collected

about Richmond. M'Clellan was waiting, it is difficult to say why, unless it was that he continued under the impression that the lines in front of Richmond could not be attacked with any hope of success without additional troops. It is perfectly certain now, that the very large entrenchments which lay between his advanced left and Richmond, covering five miles of ground, and which were supposed to be of the strongest nature, existed only in the Northern imagination. There were no works, indeed, except in the immediate vicinity of the city. However, the name of the thing, and the fact that Richmond was defended by a large and successful army, prevented M'Clellan from pushing forward. At last he took courage and advanced; and on the 25th of June he again pushed his left towards the city. General Hooker had a skirmish with the Southern troops in that direction. Hooker occupied about a mile of ground, and the victory was reported at Washington. But that victory was the last. Some deserters came in, and M'Clellan learned that General Jackson, with 30,000 men, was arriving to join Lee's army at Richmond. Before he had time to think of what he should do, or whether under these circumstances he should stand and hold his ground in the face of a superior army, as it would be, he was attacked. On the 26th the Southerners began to cross the Chickahominy on the north side, partly with the intention of meeting Jackson, who was bringing his troops down from Hanover Court House, and partly because they wanted to get behind M'Clellan, and sweep down upon his troops in rear, and drive him away from them into the swampy piece of ground which lies between the Chickahominy and the James. In the meanwhile, lest he should get to the James river, another part of the army was to make their way through the swamp and take him in flank, if he attempted to go there. It seems the Southern general tried to do rather too much with the forces he had: they were not sufficient to carry out his purpose fully. The first part of his plan, the movement to the left, was completely successful; the other, the attack on M'Clellan's flank in the swamp, was as completely unsuccessful. On the 26th the attack began on the troops on the north side of the Chickahominy, and it was successful. On the 27th the attack was continued, and was called the battle of Gaines Hill. From ten o'clock in the morning, to two o'clock in the afternoon, the Northerners, with two divisons under General Porter, had defended the bridges which they had thrown up behind them over the river, for the purpose of securing the passage across. M'Clellan, seeing that the attack was coming from the north side of the Chickahominy, now determined to give way to that attack, to a certain extent, to abandon all his supplies at White House, at the depôt he had made, and move across the swamp to the south to the James River, where he had sent orders previously to have some ships waiting with supplies, in case he should be driven to that side. Porter's orders were merely to defend these bridges for a certain time; and on the day of the battle of Gaines Hill, they were defended for some hours very well; but the Confederates, under Jackson and under General Hill, were pressing them pretty hard. Still the ground was difficult, and in that swampy, woody country, the battle became reduced to

merely a series of skirmishes. I am told that no great progress was made on the Confederate side; and when Porter sent for reinforcements, a part of M'Clellan's staff was sent to see what the matter was. Those who read the French account of the campaign, which was written by an eye-witness, will see generally what happened. There being about three parts of a mile on the north side of the river covered with Federal troops, the troops in the rear began to give way. Not those fighting in front of the enemy, but those in the rear; they began to give way at first by twos and threes, walking over the bridge; then by companies then by whole regiments. M'Clellan, and his staff, did their best to stop them, but in vain. The men had made up their minds that it was time to retire, and retire they would. "We have got no more ammunition!" "I guess we have had enough of this!" "I guess those Southerners will be down to the bridges before long!" That was the only answer they gave to the remonstrances of M'Clellan and his staff. Gradually, the panic, which began in the rear extended to the front, and the men who were engaged skirmishing with the enemy, and who, from being enveloped in their own smoke, had not for some time seen what was going on behind, also withdrew and joined in the retreat. At length came up the reinforcements for Porter, who at this time was overwhelmed with stupor at the conduct of his men, and unable to do anything with them. The reinforcements came up under General Meagher, consisting of the Irish regiments that had been placed under his command. The men were warm with marching through the swamp; they threw off their coats, ran over the bridges, and charged on the Confederates. They made a great deal of smoke and noise, and did all that was necessary. The Confederates at this particular time—as often happened to them—had exhausted their ammunition, and were unable to press their success; and although twenty-five guns had been abandoned by the enemy, the Confederates scarcely advanced at all. That night, they remained where they were, the men were wearied out, and they had no more ammunition.

For the next two or three days, the march across the swamp to Turkey-bend, in the James River, was continued. M'Clellan was not seen in the front in any of these battles. It seems a very strange thing that M'Clellan did not take personal part in the battles in the peninsula; until you consider that he had not got a Commissariat, and that he was obliged to look to what was most pressing, which was the convoy necessary for such an immense mass of men and materials. He did all this in person. His conduct was so cool and collected in the midst of everything that could try a general, that it communicated confidence to the whole army, and restored something like discipline among them. He brought his army safely across to the James River, and, as I hinted just now, the attack made by the Southerners on his flank was unsuccessful. Probably Lee had divided his forces too much. M'Clellan reached Turkey-bend, and took up his position there; and having got there, it was evident he must rest there for a time. He had no means of forcing his way on to Richmond. The gunboats had already tried once to make their way up the river, but had been

stopped at Drury's Bluff, and beaten back with some loss; and his army, owning to a loss of 17,000 men in the six days' operations, was reduced to a number too small to make it hopeful to attempt another advance, and but too happy to hold its own.

He wrote to Washington for reinforcements, and he did not get them. The Cabinet of Washington either had other plans, or they had lost all confidence in M'Clellan, or they were jealous of him, and would not grant his request. At all events, they were carrying out a plan of their own, with the view of creating a diversion. They were moving an army under General Pope, whose orders were to penetrate as far as he could at any rate to that point called Gordonsville, where he would interfere with the railroads which lead into Richmond; and if he got there, he would draw the Southern army in that direction, and M'Clellan would be able to make a safe retreat. Pope advanced. He left Alexandria with an escort, and in a sort of manner which seemed to suit the character of a man who indulged in braggadocio and gasconade, and who was given to celebrate victory before it was won. The victory, however, he did not meet with. In July, whilst M'Clellan was lying on the James, he made his way south, and his cavalry got within six miles of Gordonsville, at the junction of the railroad, but he never reached that point. Hearing of what he was doing, Jackson was again despatched to the north to meet and check him; and on the river Rappahanock he was checked, and driven a few miles back. The first action that took place in Pope's campaign was at the hill called Cedar Mountain, on the Rappahanock, where Jackson crossed and engaged Pope, in something that might be called a skirmish, or a battle, as you please, which had the result of giving Pope a very wholesome dread of his enemy, and keeping him stationary for many days afterwards. These many days were occupied by the Southerners in bringing up the main body of the Southern army, whom they found could be spared from before Richmond, now that there was no longer any fear of an advance by M'Clellan, in order to operate against Pope. When Pope, whose head-quarters had been at Culpepper, ascertained that the army in front of him was commanded by Lee in person, he knew that it was a formidable one. He accordingly fell back—and did that part of the business well—behind the Rappahanock.

It was now drawing towards the end of July, and Lee lying along the river, and pretending to cross it at several points, managed to occupy his enemy, while secretly Jackson moved with his corps of three divisions high up the Blue Ridge Mountains. On the 25th of August, you find that Jackson left the extreme left of his own lines, passed over the river, went right into the mountains, came out on the railroad at Thoroughfare Gap, descended very nearly by the line of that railroad, until he came down on it again within a few miles of Pope's rear. Pope is the general I had in my mind, when speaking of the necessity of having rules of war. Pope was the general who announced loudly to his army on starting on the campaign, that he had heard a great deal of lines of communication and lines of retreat, but that the only retreat he knew of was the retreat of his enemy.

Nevertheless, when Jackson descended and established himself in his rear, Pope thought it time to move, and he did move in a very prompt and active manner. The only praise he gets in this campaign is, for the energy with which he kept that line which he so despised before. He broke up the whole of his army instantly, and moved, in three columns, in the direction of the railroad junction.

Then took place what is called the second battle of Bull's Run, on the same ground exactly on which the battle had been fought in 1861. The battle took place on the 29th of August, Jackson occupying nearly the same ground that the Northerners held in the first battle, only with his back towards Washington, while Pope, coming from the south, occupied the ground that the Southerners formerly held, and had his face towards Washington. A hard fight did take place. Pope did force his way through so far as to gain the direct road to Centreville, and Jackson retreated a mile or two towards the hills, thereby giving that opening to the Northern army. But it was a battle fought by Jackson with 30,000 men, against 60,000 men under Pope. The next day, another corps of the Southern army, under General Longstreet, came and joined Jackson, making the total of the Southern army 200,000 men, as it was stated at the time; but their real numbers were 45,000. They fell on Pope the next day; and the battle being continued much under the same circumstances as in the previous year, Pope's men were naturally disheartened. They were depressed, and it is not surprising that they lost the battle. They left their wounded in the hands of General Lee, and went off in the direction of Fairfax. They occupied this for a day. But another movement of Jackson had the effect of driving them off into the lines of Washington, and apparently in a very unhappy state of mind until they got well inside.

As the time allowed me for the lecture is nearly over, I can only refer shortly to the remaining circumstances of any importance in that year. General Pope, having thus finished his command unhappily, was dismissed to a small and obscure post in the north-west. He was succeeded by General M'Clellan, for the Washington Cabinet, who had thought altogether of superseding that General when he returned with his army from the peninsula, now looked to him as the only man who could save them. General Lee had crossed the Potomac now, and had carried the war into the enemy's country by entering Maryland. M'Clellan took command of the army of the Northerners at Washington on the 2nd of September. By the 7th, having allowed himself five days to organise them into some sort of moving order, he began to move out of Washington, and directed his course against Lee. Then took place the great battle of Antietam Creek; and although the numbers have been much exggerated, we must say it was a very important battle. M'Clellan coming up, found Lee at first only in command of 35,000 men, because nearly one-half of the Southern army was engaged in the siege of Harper's Ferry, a large depôt of stores, which had been occupied for the purpose of invading the Shenandoah Valley. It fell, after two days' siege, into Jackson's hands. While Jackson was thus engaged, M'Clellan attacked Lee. The battle, which took place on the 17th of September, was preceded by a

skirmish on the 14th. Whether it was that M'Clellan's newly organised army could not be got over the ground, or whether he moved too slowly, certain it is that the day before the battle on the 17th, he, with the whole of his troops—all but one corps—looking on, amounting to 80,000 men, allowed General Lee to face him with 35,000, and did nothing that day. The opportunity of fighting a battle to advantage passed from him. That very night Jackson, having successfully accomplished the siege of Harper's Ferry, arrived from that place in time to take part in the battle. His divisions came up in the course of the day. The Southerners were now 60,000 strong, nearly equal to the enemy, and were in a strong position as well. The result of the battle was indecisive; but it had the effect of compelling the Southerners to leave that country, because they could not make any further advance. Standing where they were, on the wrong side of the river, and in the face of M'Clellan's forces, they had nothing to do but to withdraw to the other side of the Potomac. The invasion itself was made with two distinct objects. One, an endeavour to raise Maryland to their side, which failed; the other, the capture of Harper's Ferry and the clearing of the Shenandoah Valley for a time, was most successfully accomplished.

The CHAIRMAN: We return our best thanks to Captain Chesney for the very interesting and lucid account he has given us of these operations in Virginia.

Evening Meeting.

Monday, May 18th, 1863.

CAPTAIN E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 4th and 18th May.

LIFE.

Mackeson, E., Capt. Q. O. L. I. Mil. 9*l*.
Clayton, M., Capt. Northd. Yeo. Cav.

ANNUAL.

Watson, G. L., Lieut. 1st Life Gds. 1*l*.
Osborn, H. J. R., Lieut. 1st Life Gds. 1*l*.
Tyrone, Earl of, Lieut. 1st Life Gds. 1*l*.
Bulger, G. E., Capt. 10th Regt. 1*l*.
Ridgway, A. F., Esq., Army Agent. 1*l*.
Colman, J. B. T., Lt.-Col., Unatt.
Moorsom, W. S., Capt. late 52nd L. I. 1*l*.
Kierle, R., Lieut. 1st Middlesex Art. Volunteers. 1*l*.
Westby, J. W., Lieut. 41st Regt. 1*l*.
Stewart, Colvin, Capt. Dumfries Mil. 1*l*.
England, Richard, Major 55th Regt. 1*l*.

ON STEERING AND MANŒUVRING SHIPS WITH BROADSIDE BATTERIES BY MEANS OF TWIN SCREW PROPELLERS.

By COMMANDER T. E. SYMONDS, R.N.

WHEN last I had the honour of addressing the members of this Institution on the subject of propelling and manœuvring screw-steamers, it will, I think, be remembered that many exceptions were taken to the views I then advanced, which, although based on absolute practice, were, nevertheless, questioned by those whose position and experience give such weight to their arguments as well nigh to crush my first attempt to introduce them. However, nothing daunted, I was content to abide the result of further experiments, feeling confident that they would tend to corroborate my statements. How far

this has been the case is now well known; the trials of Mr. Dudgeon's vessels, "Flora," "Kate," and "Hebe," having confirmed the advantages I claimed for the method of propulsion I then advocated. Recents events in America have verified my prediction as to the fate of those ships not possessing the qualities of steering and manœuvring which can alone be obtained by the application of twin-screws, worked by separate and independent engines.

As those objections appear in Vol. VI of the Journal of this Institution, it will, I think, be only just to the system, and to myself, that some record should appear of the facts which have since been elicited by the performance of the vessels quoted. Stubborn facts that must banish a host of theories, and that have at last awakened an interest, and invested the subject with an importance which I have long contended was due to it.

I have selected the trial of the "Flora" on this occasion, she having not only stood the test of the experiments on the Thames but of ocean service, and, therefore, furnishes the best example for practical purposes.

"*Flora's*" *Trial.*—The "Flora" is an iron vessel of 450 tons, 160 feet in length, $22\frac{1}{2}$ feet in breadth, and $15\frac{1}{2}$ feet in depth, having two independent engines, with a collective nominal power of 120 horses; the screws working under each quarter before the rudder, as in Plate xxvii., figs. 3 and 4. The diameter of the cylinders is 26 inches, with a stroke of 21 inches; diameter of screws 7 feet, pitch $14\frac{1}{2}$ feet. There are two tubular boilers working at 30lb. pressure, and one high pressure working at 50lb. This high-pressure boiler is intended to be used for producing a steam blast in the chimney, and to dry the steam (by admixture) from the two common boilers. *The first experiment* was made with both engines, going ahead at full speed, and the helm hard over, when the first circle was made in 3 minutes and 14 seconds, the second in 3 minutes and 13 seconds, and the third in 3 minutes and 16 seconds (the ordinary time, with one screw, being about 5 minutes); the diameter of the circles being about three lengths of the ship, and lessening each time. *In the second experiment*, one engine and screw worked ahead, the other astern, helm hard over, one circle was made in 3 minutes and 30 seconds, and another in 3 minutes and 40 seconds. In making these circles the action of the ship's hull was extraordinary, the central part being stationary, and both ends moving round equally; the circle was then made on a pivot from the ship's midship section. The vessel was then put on a straight course, stopped, and from a state of rest the engines were started, one ahead and the other astern, helm amidships; the circle being completed in 3 minutes and 55 seconds, the diameter of the circle being, as before, within the ship's length.

"*Kate's*" *Trial.*—In the first trial of the "Kate," a sister vessel, experiments were made in steering with the screws, when going *full speed astern*, which were attended with the most complete success, proving that a ship running into danger, or requiring to back off so as to *renew her attack as a ram*, might do so with the utmost facility. The "Flora," on her passage over to America, worked one screw, one engine and boiler, on alternate days, making an average speed of

8 knots. She has an immersed midship section of 200 feet, and with an average consumption of 11 tons of coal per 24 hours; attained a speed, with both screws, of 13 knots an hour, carrying a cargo of 300 tons on a draught of 9 feet of water.

It must be observed that, although the results described were most satisfactory, neither the lines of the "Flora," nor her proportions, were by any means calculated to develope the full power of the "twin-screw" system as it might be applied to war ships, which would be comparatively broader; and, therefore, having the screws further apart, their steering and manœuvring power would be much enhanced, while, from being heavier and lower in the water, they would not be so much affected by the wind, which had a very material effect on these light vessels, they being very high out of water, and only in ballast trim, their screws were 6 inches above water, so that their full effect was not developed.

This little vessel, originally designed for trading service in the China rivers, soon changed hands on her superior qualities becoming known, and she is now celebrated as one of the most successful runners of the blockade in America—for which service, from her high rate of speed, light draught, and extraordinary turning power, she is eminently calculated. In this vessel, the "twin-screw" principle has stood the commercial test, which is a very important one; and it must be a gratification, beyond mere gain, to her clever and spirited constructors to feel that, in the face of much opposition, they have been the means of proving the advantages to be derived to this great maritime country from the "twin-screw" system of propulsion; and I feel sure that it will be hailed with pleasure here, that their enterprising spirit has met with that success which skill and perserverance seldom fail to achieve in commerce, and that all will agree that the country is indebted to the Messrs. Dudgeon for their practical exposition of the advantage of the system as applied to ocean steamers.

They are now building eight or nine vessels on this principle, varying from 500 to 1,500 tons.

Although neither claiming for myself or Mr. Roberts priority in the invention of twin-screws, I think it but right to assert that he was the first to show the proper and most effective system of fitting and applying them, that is, with separate and independent engines, which is the pith and marrow of the system, as I have before described, and to which he has added double keels and rudders, as seen in Plate xxvii., figs. 1 and 2.

The original method of fitting twin-screws was crude and imperfect, the method of attaching them to the quarter first adopted, being still adhered to, as in Figs. 3 and 4. They appear to have been applied hitherto simply to attain a speed at light draught, unattainable by a single screw, and to dispense with the cumbrous and costly paddle-wheel.

The advantages of independent action appear to have been either overlooked or disregarded in this country, until Mr. Richard Roberts's application of separate and independent engines to each shaft (a method constantly advocated by him, since 1852) which, by dividing

Arrangement of Twin Screws.

Fig. 1.

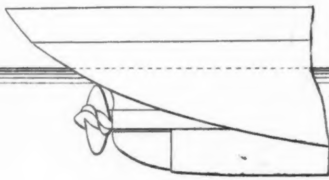
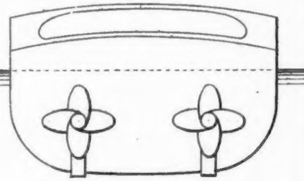


Fig. 2.



Improved System, with two Keels.

Fig. 3.

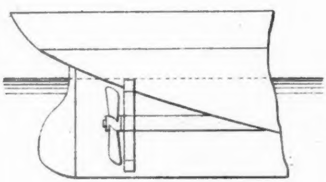
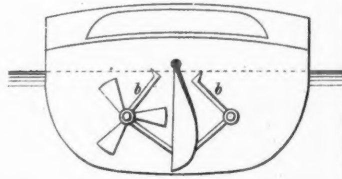


Fig. 4.



Present System, Single Keel.

Fig. 5

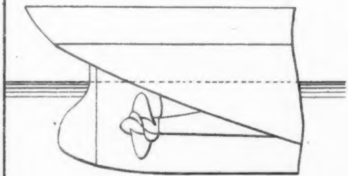
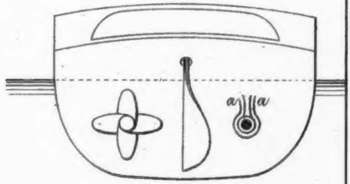


Fig. 6.



Improved System, – Single Keel.

J.R.Jobbins.

the engine-power, makes the otherwise ponderous machine lighter, less costly, and more manageable in working; or, in the event of injury, enables one set of engines and boilers to be worked with one screw, as in the "Flora" and "Kate," outward bound, and gives that extraordinary power of manœuvring and steering already described. This Sir J. Elphinstone graphically referred to in the House of Commons, in a late debate. Beyond this, Mr. Roberts applies his screws in a manner totally novel, and I believe very superior to any existing arrangement, which is calculated to combine strength with simplicity and lightness of construction, and to develope the properties of the system to its fullest extent, without incurring the same risk of fouling or accident to which the present plan of fitting them is liable.

Having minutely described this arrangement in my previous paper, read at this Institution in March, 1862, I beg to refer to Vol. VI. in which it appears, and to the diagrams and models on the table, showing the method of fitting twin-screws with two keels and two rudders, as Figs. 1 and 2, Plate xxvii.—Figs. 5 and 6 being a method of fitting twin-screws to single-keeled ships, substituting webs (*a*) to connect the trunk through which the shaft passes to the quarter, instead of the V outrigger bracket (*b*), as shown in Figs. 3 and 4 in the same Plate.

This application is, in the opinion of many competent judges, who have closely watched the experiments, specially suitable to war-ships of all denominations, in which every tendency to accident or detention should be scrupulously avoided—delay being often defeat. It will be observed, by referring to the Figures 1 and 2 in Plates xxvii. and xxviii., that both the propelling and steering agents are removed as far as possible from injury by shot or other contingencies, both being so deeply immersed, and independent of each other, as to ensure their constant and uninterrupted action, either separately or in conjunction—rudders and screws being defended without malformation of the after-body; points which I submit are, in a military point of view, of the most vital importance. To assume that this, or any other arrangement of a machine so complicated, and liable to so many vicissitudes as a ship, is perfect, or free from all contingencies, would be simply absurd; but I do claim for this arrangement an immunity from many of those dangers to which the present system is so constantly liable; and if by accident any one part is injured, there is a duplicate which will, on all ordinary, and most extraordinary occasions, supply its place, and thus prevent the utter helplessness which must ensue if any one part of the present arrangement with one screw, becomes deranged.

The leading characteristic in this system of construction is, the absence of those enormous forgings for the stern-posts of single-screw ships, which take from nine to twelve months to make, and sometimes prove faulty when finished.

The stern-post of the "Minotaur" weighed nearly 150 tons in the rough, and when planed down and fitted, 70 tons. It has been stated that the cost of this triumph of mechanical skill was over 6,000*l.*, which will represent something equivalent to $2\frac{1}{2}$ per cent. on the whole value of the hull. This might be saved by the adoption of our principle of fitting the twin-screws, in which no forging of any

considerable weight is necessary. If required on an emergency, half the fabric would be erected, ere the gigantic forging had left the smithy.

Screws.—I cannot leave this part of the question without drawing your particular attention to the character of screw-propeller in the different plates, models of which are on the table. This propeller, no matter what its other qualifications may be, is decidedly non-fouling, and, therefore, fulfils a desideratum of such importance in war vessels, as to demand a careful experiment of its mechanical effect. Both Mr. Roberts and myself have for many years advocated this form of propeller with four blades, claiming for it, in addition to its non-fouling qualities, a total absence of vibration.

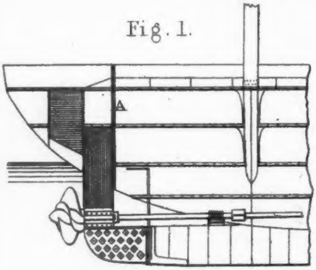
Its form and method of application differs materially from any hitherto used, and its construction will be found stronger, lighter and cheaper than that of the present propeller. The trial of the four-bladed screws in the "Emerald" and "Shannon," appear to bear us out in our view of the advantages due to four blades. When I say it is the invention of the greatest mechanic of the age, it is at least a guarantee that some thought has been bestowed upon it, and who will say that it, or some modification of it, will not produce results equivalent to any already attained, especially when applied in the manner proposed. Suppose, for the sake of argument, that it does not develope the same mechanical effect as has been produced by other screws; when efficiency is the object, expense is a minor consideration, and to ensure a non-fouling propeller, a slight increase of power, or a trifling diminution of speed, is not to be considered in comparison with its other invaluable property, especially in vessels of a certain class, which, in river warfare, would have to grope their way among natural and artificial obstructions.

How different might have been the result at Charleston, had the Federal rams been fitted with two screws, so as to have taken up their stations as did the "Keokuck," and were those screws non-fouling, bidding defiance to the obstructions by which many of them were placed *hors de combat* before they came into action. I may here remark, that the very device I mentioned in my last paper here, as the most likely to be effective, was the one resorted to in the defence of Charleston, viz., staking fishing nets, this my own experience on our coast had shown me was the most fatal obstruction to the screw in its present form.

In ships recently constructed, it has been deemed advisable to dispense with lifting the screw (its only chance of clearing when fouled), and why? It has been found at last, as I ventured to predict, that the after-body is so much weakened by the screw aperture and well, that to save the ship from premature dissolution, it is found absolutely necessary to close them. Imagine one of these ships with her screw fouled—say with a lead line, a hawser, or a boat's painter—in what a predicament would she be placed, having nothing to rely upon but canvas, under which, even in a working breeze, she would require a space of 6 or 7 miles to wear in, and, perhaps, would not stay at all. These are seamen's questions dictated by experience, that no landsman

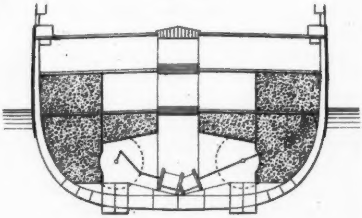
ARMOUR PLATED SHIP, SHEWING TWIN SCREWS, KEELS, AND METHOD OF LIFTING SCREWS.

Fig. 1.



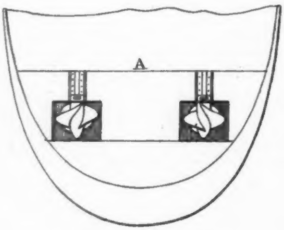
Longitudinal Section.

Fig. 2.



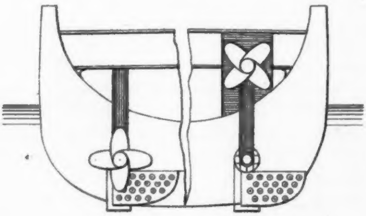
Midship Section.

Fig. 3.



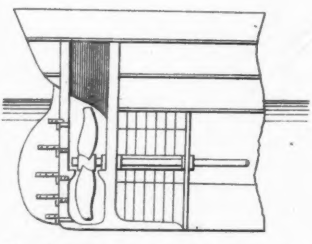
Deck Plan.

Fig. 4.



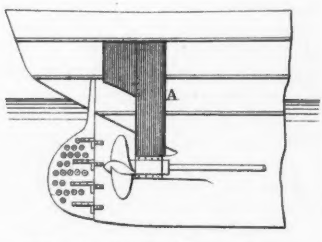
Transverse Sections.

Fig. 5.



Section of After Body of Warrior.

Fig. 6.



Warrior fitted with two Screws.

J.R.Jobbins.

can be expected fully to appreciate, and that none have hitherto solved. As seamen, we must be consulted, or where shall we be in the event of a war? It will be useless for our shipbuilders to attempt to console us by the assurance that this or that ship could have steamed 14 knots had her screw not fouled, or had she answered her helm; such assurances will not uphold the glory of England, nor give confidence to those who have to fight her battles on the ocean.

Lifting Screws.—The opponents of the twin-screw system will doubtless say, your two screws will present the same objections, if not non-fouling—granted; if not non-fouling, they may. However, anticipating this objection, I have designed a plan for lifting them, whether in my own double-keeled ships, or in those with single keels. By this method, these smaller screws may be lifted separately through either quarter, the apertures in this case not interfering with the central strength of the ship, as in the single screw; the screws, when lifted, being housed, and the apertures closed by flaps or slides. (See Plate xxviii, Figs 1, 3, 4, and 6.)

The screws being thus lifted, and the apertures closed, the ship is to all intents and purposes a "sailing ship." There being no aperture in the dead wood, as in a single-screw ship, the water has a clear delivery, and is led direct to the rudder instead of escaping through the screw aperture, the steerage will therefore be as perfect as in a sailing ship. If, in a stiff breeze, on a wind, it be found desirable to assist the ship by steam power to keep her to windward, the lee screw may be lowered; which, when the ship is at a considerable inclination, will work to great advantage, being more deeply immersed; *and thus half power may be made available at full speed under canvas*, which could not be the case with the single screw. With the lee screw thus working, a ship would not readily fall off in the trough of the sea, as is often the case from inefficient steerage power and other causes; and even if thrown on her beam-ends, there would be a better chance of righting her, by driving her head to wind or sea, by the same means; whereas the single-screw would be partially out of water and comparatively useless for the same purpose.

Perforated Rudder.—While on the question of steerage, I cannot forbear mentioning that I believe it will be found injudicious to increase the area of rudder to such an extent as has been recommended, and to apply steam or hydraulic power to actuate it; thus effecting by overwhelming force that which may be attained by other means. I believe that such appliances may work very well in fine weather, but that in a sea-way they will be found too rigid and unyielding; and that either rudder-head or post will give way. If much additional area is found necessary, I believe the perforated rudder will be found to answer. (See Plate xxviii, Figs 1, 4, and 6.)

The orifices or perforations in this rudder increase in size from the centre of the thickness of the rudder on both sides (*i.e.* are countersunk), and expose a series of surfaces at a considerable angle with the plane of the rudder. In putting the rudder over, these openings will reduce the lateral pressure, allowing the water a free passage through them, which will enable the rudder to be got over to a greater angle,

with less power in a shorter time. The series of surfaces so formed being acted on by the water nearly at right angles, the steering effect will be greatly enhanced.

A rudder of this description, when struck by a sea, or in case of gathering stern-way before it could be righted, would not be so liable to injury as the ordinary rudder. This principle has been adopted in China for centuries, and I believe it to be a cheap and simple method of improving the steerage of ships in which an increased area of rudder is required.

Since bringing forward this rudder, I have ascertained that the "Glatton," on her outward voyage to Malta, was steered with the utmost difficulty; but on adding a considerable piece to the after-side of her rudder, and perforating the whole surface with 6-inch holes, she steered well.

I propose working this rudder by a wheel I have lately invented, with which I would undertake to steer the "Warrior" better in a sea-way, than with any steam or hydraulic apparatus, it having sufficient power and a compensating quality that would obviate all chance of jerks and strains consequent on the former method, and with less liability to accident. (See Plate xxxii.)

However, for all extraordinary occasions, when a sharp turn is required, I infinitely prefer applying the propelling power as a steering agent (as in the "twin-screws"), which, proceeding from the source of motion, acts more directly and with greater certainty on the course of the ship when required to turn rapidly; thus obviating the necessity for increase in the area of the rudder, or any mechanical appliance beyond that of the wheel. This recent practice has proved.

Now I by no means undervalue a reasonable application of mechanical aid on board ship, but I do consider that a wholesale adoption of delicate machinery will be attended by many disadvantages, and I think the effort should be in the direction of simplicity rather than complication, which appears to me to be the bent at present. Every piece of machinery that is put into a fighting ship entails additional hazard, the slightest defect or accident throwing it out of gear, and thus leaving us in a worse position than if it had never been applied, unless provision is made for attaining the same result by manual labour in case of a break down. Moreover, it adds vastly to the expense, occupies room, and increases weight. We have lately seen the formidable results of the damages done to the machinery of the revolving guns when under fire—we have yet to learn how far they may be exempt from similar peril in a sea-way—at present all is speculation. In the meantime, therefore, it behoves us to look closely into any other means of accomplishing the same end, lest the former should break down, and we may be found wanting in the hour of need.

Previous to the very partial development of the twin-screw system of propulsion that we are at present acquainted with, there seemed no other alternative than to trust to the revolving shield; ships with broadside guns, no matter on what principle, when propelled by the single-screw, being notoriously deficient in most of the requirements of modern warfare. The twin-screw system, however, has not only furnished

a means of making broadside gun-ships equally, if not more formidable, than the cupola ship (they being most suitable for general purposes), but has supplied that system with an invaluable adjunct, without which, if successful on other points, it would be very imperfect, as was proved at Charleston, when the "Ironsides," partly from her great draught, but more especially from her bad steering qualities, became utterly unmanageable, and was as much at the mercy of the tide as of the enemy; the smaller Monitors being steered with much difficulty, and almost equally unmanageable. The "Keokuck," fitted with "twin-screws," was the only vessel in the fleet capable of taking up her position, which, as has been seen, cost her dearly, and had it not been for her peculiar cellular construction, she would have gone down at her station. She was struck 90 times, and had 19 holes above and below water line, some of a size through which a boy could crawl.

The cellular system adopted in this vessel is precisely similar to that illustrated by me in the Journal of this Institution, and laid before her Majesty's Government two years ago, and is strictly in accordance with that laid down for larger ships by Mr. Roberts in 1852, and as shown in the illustrations.

It is very clear, from the experience thus furnished, that it is as indispensable to have some certain means of bringing guns into action, as it is to have the power of working them. For my own part, I sincerely hope, both for the good of the country as well as for Captain Coles' sake, that his shields may prove an entire success, although I do not agree with him in condemning all broadside ships, and claiming for the cupula system all those advantages he believes it to possess, especially for sea-going ships. In any observations I may make I distinctly repudiate all idea of antagonism to his or any other particular system, my object being the benefit of the public service.

The position I take is, that ships, whether sea-going or otherwise, may be constructed, or that ships of the present build may be so altered, as to fulfil most, if not all, the conditions he claims for the cupola ship, at a less expense than the cupola involves, by the adoption of the "twin-screw" system, and that ships so fitted will carry a more efficient armament of the largest guns *that have hitherto been proved fit for sea service*. It is with such guns, I think, we should deal, and not with untried guns of the tremendous size and weight we hear advocated, that may after all prove impossible in a ship. It will never do to have these guns on paper alone; they will not fight our battles any more than paper battalions. Leaving, therefore, guns of the future to ships of the future, and taking the 100-pounder as the standard, the broadside of the cupola ship dwindles down to one-third of its assumed weight, leaving at least an equality with the broadside system, provided the broadside cannot carry a larger number, which, on the same lines, I believe it will be found in practice that it can. It appears to me that, until the character and capability of working these ponderous guns on shipboard, and the practical advantage of the prodigious missiles they throw, is decisively established, that there are many considerations to be taken into account against their use. I cannot yet learn that these prodigious missiles have been particularly destruc-

tive in practice afloat. A ship with two such guns is but a two-gun ship after all, and an accident to one, deprives her of half her power without the means of replacing it readily. Moreover, the liability of accident to the machinery required, is much against them. Until some decided advantage has been shown to belong to the proposed concentration of armament, it would be wrong to calculate upon it; and certainly the experience gained in America does not seem to give much promise of their ultimate adoption. Nor do the turrets appear to possess in practice that immunity from being struck which has been claimed for them. The "Keokuck" received 90 shot—15 in the after-turret, 12 in the fore. The "Weehawken" was struck 59 times, her turrets badly indented and working with difficulty, many bolts loosened and driven through. The "Passaïc" 50 times, her turret being so bent as to deprive her of all offensive power, and the turrets and pilot-houses of the others were all more or less damaged. The "Watenket" was struck 51 times, and her turret stopped twice by shot. These accounts are by no means encouraging, and should serve to cause some hesitation ere broadside guns are discarded. I may here remark that although the "Ironsides," on the broadside principle, was struck between 60 and 70 times, she sustained no material damage.

There are, however, many situations, which must occur to any practical man, in which the revolving turret might be of great advantage—the ship aground, for instance (if upright), and in a narrow river, or any position on which there might not be room to turn, as has been described. These, however, are exceptional cases, and therefore do not apply generally.

Turrets will, in any case, be of little use, if the ship that bears them refuses her helm, and cannot take them into action. Now, there is no lack of seamanship in America, and as has been proved, no lack of pluck; therefore there is little doubt that every possible device was practised to get these ships into action; *but their mechanical appliances failed them, both as regards their steerage and turrets*, and all courage and seamanship were of no avail. With the grave duty before them of taking Charleston, this cannot be looked upon but as a failure. I ask, if such a *contretemps* had occurred to our own armour-clad fleet (and it is quite possible), what would the world have said—where would have been our prestige on the ocean?

Rifled Cannon.—Although not disputing the advantages of the superior smashing effect produced by heavy smooth-bore guns at high velocities, I think their advocates have lost sight of the fact that, under many circumstances, a good sea service rifled gun is capable of inflicting more real injury, as it has been proved that such a gun as may be readily carried either on the upper or main deck of a ship is capable of punching a hole clean through any amount of armour that can be safely applied to a sea-going ship; and, if this can be done, one such shot or shell passing through the side into the engine- or boiler-room, will effect at one blow ten times more injury by damaging the engine or exploding the boilers, than could be accomplished by a smashing shot, which would require several discharges before the same object be attained. I do not profess to be an artillerist, but from all I gather, whether from experiments or discus-

sion, it seems to me that if you can have a safe rifled gun, say a 100-pounder, that accomplishes such an object, that both from its handiness and power of piercing, it is a more efficient weapon for sea service than the monster guns of the future, which could not be worked in reasonable time by ordinary appliances, and are likely to be totally unmanageable in bad weather. At all events, no ship should be without them. I should much prefer three 100-pounder guns, whether rifled or smooth, that can be readily served, to one 300-pounder. The former might be fired twice or thrice to once of the latter, and would on those repeated discharges produce more effect than the one. Moreover, if one became injured, there would be two still left capable of inflicting the injury described, whereas the loss of one gun to the cupola would be fatal. Such guns, we know, can be readily fought on the broadside, and therefore do not require a turret to carry them. I am of opinion that Captain Coles claims too much for the sea-going qualities of his ships, which are as yet untried. They are low in the water as compared with ordinary ships—the actual side of the ship shown in his diagram being only 7 ft. 8 in. above the water-line, the whole defence from a sea being the flying bulwarks or flaps, the efficiency of which to resist a sea I doubt. A first-class frigate often ships a heavy sea over all—her side being some 13 feet higher than the top of his moveable gunwale. Such a sea would clear a turret-ship's decks. I think, therefore, until we have arrived at some method of construction which gives us qualities infinitely superior to those we at present possess, that we cannot rely on such a ship for laying-to safely in a heavy sea. Nor can we dispense with an upper deck, on which a sufficient proportion of boats and spars can be stowed with safety, and with stout bulwarks to protect them. Iron can only sustain a certain amount of strain, and no amount of iron could be conveniently put into those flaps, so as to sustain such a weight of water as must occasionally be thrown upon them on shipping a heavy sea. If not broken, they would be bent, and thus disabled. If engaging an enemy under canvas, in a double-reefed topsail breeze, perhaps chasing him, how are these flaps to be lowered with any degree of safety, to fire a gun? The sea would make a clean breach over all, and certainly sweep her decks fore and aft, if not break into the cupolas, her only means of ventilation, which, under such circumstances, must be kept open, the hatchways being necessarily battened down. In pitching or sending, the flaps would inevitably be broken or bent. The same objection may be raised to rolling in a heavy sea.

In the diagram Captain Coles shows in Fig. 10 of his pamphlet, the same sea he has made to break into the port of the broadside ship, would wash up to and over the base of his cupola, and possibly into it, or certainly would pour down in no very genial shower through the groove, and flood the lower deck.

If a gale of wind springs up after an action, in which these gunwales would inevitably be so injured as to prevent their being raised, in what state would the ship be to repair damages?

However, supposing that the broadside ship cannot fight her lee

guns in the same sea as a cupola ship (which I by no means admit), still she has upper deck guns, which may be fought with advantage under such circumstances. Both these and the main deck guns may be fired on the top of the rolling motion, which is well known to be the most effective time; this the cupola gun cannot do, as her side would obstruct the object from view. In carrying on in chase or being chased with the ship heeling, say 12 degrees, the cupola ship could not bring a single gun to bear on an antagonist to windward, or astern of her, whilst the broadside ship might fire her main or upper-deck guns into her bottom, or work her bow chasers with effect, and if to leeward, into her deck and turrets.

In fighting at close quarters the cupola-ship being lower, would be under many disadvantages. The upper-deck guns of the broadside ship would bear on the top of her cupolas and decks, and musketry would pick off the men at the gun, whereas the difficulty in boarding from the lower ship would be greatly increased.

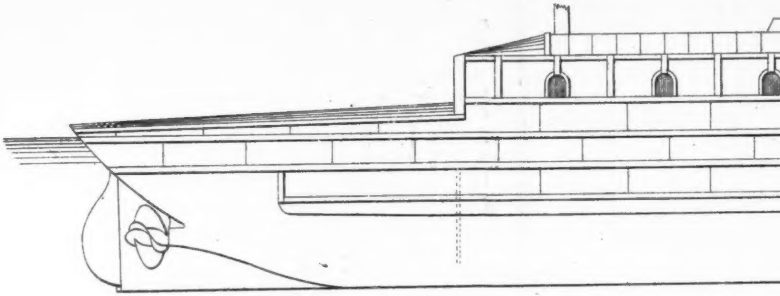
I am disposed to attribute much less importance to the entire protection of guns than is generally awarded to it, for although the effects of the shot may be terrific, there are fewer of them, and shells are not to be feared as much on the upper deck as they are elsewhere. Armour our ships from the main deck downwards as heavily as possible, so as to protect the engines and boilers, and make the upper deck in some degree proof to vertical fire, and I think I speak the sentiments of the profession, when I say that we shall be content to abide the same chances as our forefathers did, and as our brother officers in the artillery now stand. I believe we would willingly give up entire protection, and secure a faster and more efficient sea-boat.

Tripod Rig.—The tripod rig necessary to the sea-going cupola-ship has to my mind the following objections:—I believe that the legs abutting on the bilges of the ship would cause much greater wear and tear on the rivets than would the wire rigging of an iron mast properly secured; they could not be cut away if necessary, and would present a much greater surface to the wind than a single mast under all circumstances. I cannot see how the haulyards, lifts, and braces, &c., are to be led through the legs without entailing endless confusion, and if carried away, how they are readily to be spliced. It appears to me that one shot passing through the leg would in all probability cut or foul several of them, and being altogether they would incur greater risk of injury than when separate, as in the ordinary method.

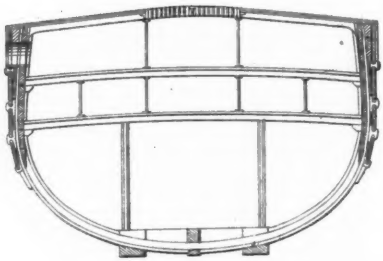
The three masts or legs will interfere with the line of fire on three points, and it will, I believe, be found in practice not possible to fire within 10 degrees on either side, thus diminishing the uninterrupted arc claimed, by at least 30 degrees, and in the heat and smoke of action it will be a great chance if they are not damaged by their own shot, and especially should a shell burst on leaving the gun.

It must also be observed that although admitting the cupola gun to fire at an angle of 7 degrees depression abeam (the angle claimed), that it will greatly decrease on training the gun forward or aft, therefore at certain angles and distances some of the guns could not be brought to bear, whereas a broadside-gun may be depressed to a much greater

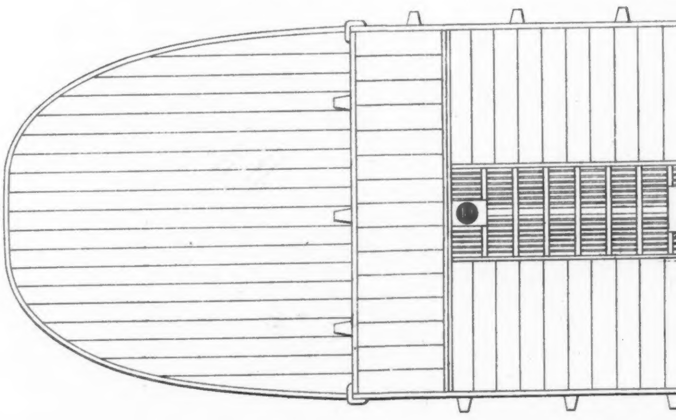
Coast Defe



Side V

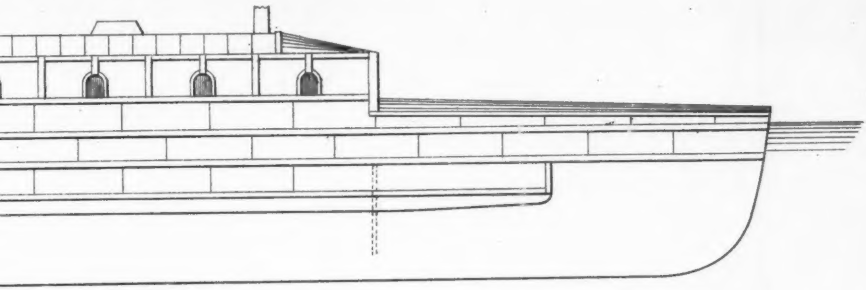


Section in Boiler Room.

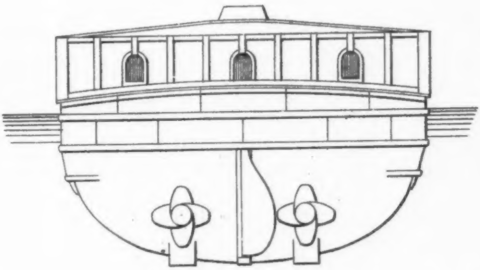


Pla

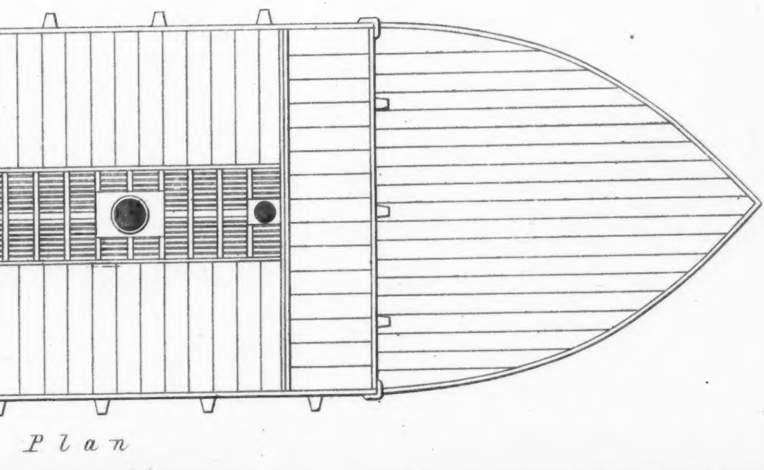
Defence Ship.



ide View



Stern View



Plan

J.R. Jobbins.

angle without such obstruction, extreme training being unnecessary when the ship is fitted with "twin-screws."

Now, I contend that by a proper application of the twin-screw principle, whether to such a ship as that now before you, or to existing ships with broadside guns, that with a comparatively trifling alteration, as compared with that necessary for fitting them with moveable turrets, most, if not all, the points claimed for the turret system can be attained, and some additional advantage secured, even in coast defence ships, for which the turret system is more particularly adapted. Judging from the difficulty and vast expense incurred, in altering the "Royal Sovereign," a ship of 3,963 tons, resulting in an armament of 4 turrets, *intended* to carry five 300lb. guns *(not yet proved fit for service, even in a coast defence ship)*, I believe that a ship of the same class altered as shown in Plate xxix, will be more effective, and cost far less.

Coast Defence Ship.—This vessel I propose to arm with 5 broadside guns on each side, of equal weight to those the "Royal Sovereign" can carry in her turrets, having the advantage over that ship, of firing 3 guns forward and aft in a line with the keel, and being cut down at either end to within 3 or 4 feet of the water-line, so as to allow the guns to be depressed without injury to the decks, these inclines being covered with rounded decks, so as to throw off the water or deflect shot; they might be fitted with flying bulwarks if found necessary.

It will be observed that all the principal plates are so arranged as not to require the slightest bending, and are secured to the side by heavy T shaped stringers, which will conduce to the strength of the ship, and obviate fastening with bolts, the space between the plates and stringers being caulked with oakum, or some soft wood, so as to keep the plates tight, and to reduce the jar caused by the impact of the shot. The upper tier of massive plates are dropped into their places vertically, and readily removed. (By this method an armour-clad ship might carry her upper plates in her hold on the outward passage.) A portion of the necessary backing is applied externally, so as to obtain a dead flat for the plates to lay against, the remainder being filled in on the interior to complete the backing, as shown. To give longitudial strength so as to enable the ship to carry the excess of weight beyond that she was originally constructed to bear, two keels are fitted under the bilges, and bolted to corresponding kelsons. These keels will defend the bottom should she take the ground, and will lessen her rolling.

The roofing, or deck, is composed of strong wrought-iron beams, covered with two-inch iron, backed by teak (or a material recommended by Captain Scott, which being non-inflammable, and free from liability to splinter, will, doubtless, ere long, be applied for backing in preference to wood), the upper part of the roof being composed of deep open bars, to give ventilation. The iron masts would spread a different area of canvas to reduce her rolling, the draught for the furnaces being derived from their highest point by means of a fan, so as to supply them with pure air, instead of that which, being near the hatchways, is mixed with exploded gunpowder, and tends to damp, if not put out, the fires.

By means of the twin-screws, the ship herself becomes the turntable for all her guns,* which may be brought into action with even greater facility than in the cupola, the ship being kept either broadside, or end on, to her adversary as required—a position which cannot be insured in a cupola-ship fitted with a single-screw. I believe such a ship would be a very formidable adversary, and with her six-inch plates, bid defiance to all artillery likely to be brought against her afloat, and be a moveable fortress, quite capable of defending the approaches to our harbours in any weather that an iron-clad fleet could attempt to operate in. Such vessels at the back of Plymouth Breakwater (their bottoms well defended from shot) would be of more service than all the guns on the heights.

Before quitting this subject I must not omit to mention what I consider a very important point, viz., that if a cupola-ship is engaged for any length of time, the guns would become heated (or might be damaged) which would necessitate a cessation of fire that would be fatal; whereas in a ship with broadside guns fitted with twin-screws, the opposite guns could be readily brought into action by turning the ship on her centre.

River Gunboat.—For small harbours and rivers, in which a ship of this description could not act, I propose the vessel shown in Plate xxx, with fixed diamond-shaped shield. This shield is pierced with eight ports, four guns being mounted, any three of which may be fired ahead, astern, or on either broadside. By this arrangement sufficient space is enclosed for working the guns, their weight being distributed near the centre of the ship when firing from the broadside, which will prevent rolling. The angular form offers two inclined surfaces that will deflect all ordinary shot better than a turret. In this vessel I conceive the properties of the twin-screw system as I propose to apply it, viz., with two keels and rudders, will be most thoroughly developed, as she will attain a speed unapproachable with one screw at the same draught of water; and from the distance the screws are apart, and the decreased area of resistance to turning at either end, she will turn with extraordinary facility. This vessel is 150 feet long, 45 feet broad, draws 9 feet water. Her shield covers an area of 1,296 square feet; armour plates 3 feet below the water line. The decks are rounded, and of cellular construction, and proof against vertical fire. I propose to fit the ports with "swinging mantelets" on the inside, which can be triced up when working the gun, and let down when the port is not used. This swinging mantelet will offer a resistance that no fixed iron shield could give, as is, I believe, well known, and would not be liable to be jammed as in the American sliding shields. I need hardly observe, such a vessel is only intended for harbour or river work, for which, I believe, she would be found

* A conclusive experiment was lately made in the "Ceres" (sister vessel to the "Flora"), when to satisfy the doubt of some artillerists on board, the vessel was turned on her centre through an arc of about 50° in twenty seconds, and when the engines were suddenly reversed she returned to her former position in the same space of time, without any perceptible check, the action of the screws being almost instantaneous.—T.E.S.

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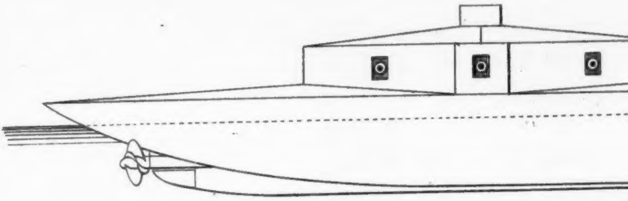
River Gun



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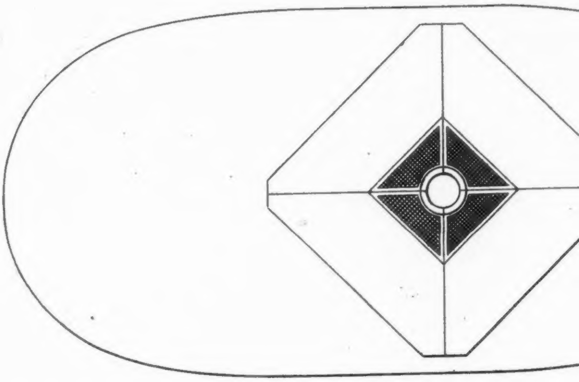
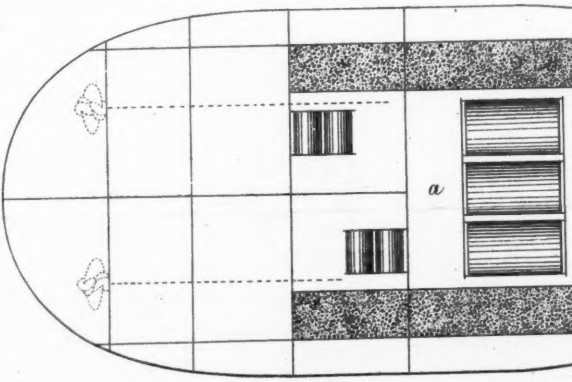
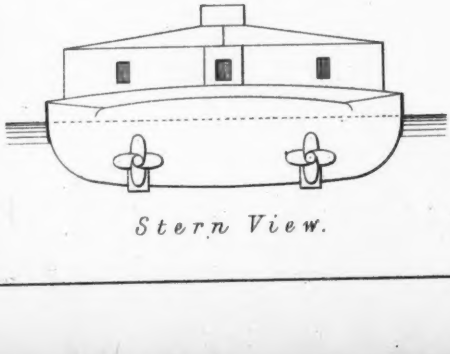


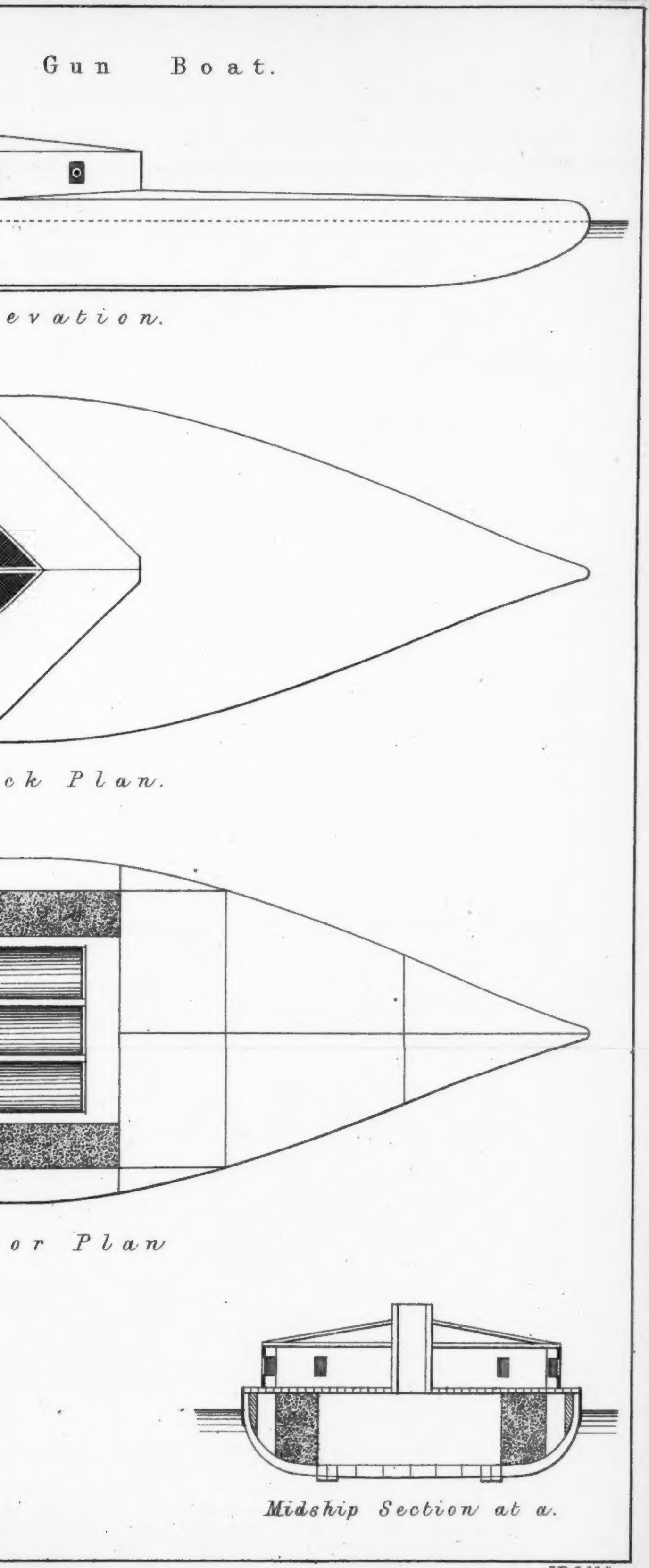
Deck P



Floor P



Stern View.



J.R.Jobbins.

effective. She might be fitted with lowering bulwarks, which would make her sufficiently seaworthy for coast purposes in moderate weather.

This shield, for working 4 guns, encloses an area of 466 feet more than 2 cupolas of 23 feet diameter, and would be 60 tons less weight when coated with 5-inch iron, than 2 cupolas with 4½-inch, and can fight 3 guns ahead or astern, instead of 2, as in the cupola—thus beating the cupola on the strongest point claimed for it, viz., on the bow attack. (See page 18, Captain Coles' pamphlet.)

However important the question of coast defence may be, it sinks into insignificance when compared with that of the sea-going qualities of ships—destined, I trust, for ever to keep an enemy at a respectable distance, to sweep him from the seas as in days of yore, and to guard our distant settlements.

It is, I firmly believe, to ships with broadside batteries, capable of fast sailing, and handy under canvas, that we are to look for such security. For reasons I have already given, in my remarks on the turret system, such ships must be incomparably better sea-boats, and in fact, to sum them up in one word, more *wholesome* (in the broadest acceptation of that term) than any turret-ship.

I am at a loss to find in what manner Captain Coles' increased accommodation is obtained in the cupola-ship, the upper and gun decks being done away with, and the turrets occupying a large portion of the lower or living deck, which, in the broadside gun-ship is clear, nor can I admit that there is any improvement in ventilation.

Looking at the question in a practical point of view, I can but agree with Sir W. Armstrong's opinion, viz.: "that the more you deviate from the normal construction of a ship, with a view of rendering her proof against shot, the more you will increase both the difficulty of construction and the difficulty of navigation."

In their construction, taking a ship as a beam, which increases in strength as the square of its depth, they are stronger having deeper sides, which, even when armoured to whatever thickness may be found by experience most conducive to efficiency, we have yet to learn will be heavier than the cupola-ship of similar proportions, and *actual* not *assumed* power.

The rig shown in the diagram is so similar to the present proportions of spars and sails, as to utilize existing stores without alteration, the difference being in the number, size, and length of the lower masts. I propose to have four iron lower masts, instead of three and a jigger, which Captain Coles recommends. The masts and sails, by this arrangement, are smaller and more easily handled, and the ship I show, will either wear or stay as well as any ship afloat, the centre of effort being in the proper place, which every practical seaman is aware is the true criterion of handiness.

By dispensing with the bowsprit, which is at best an awkward appliance, and a great weight over the bows, I consider a desideratum is obtained in a ship that may be required to act as a ram, and to fire guns right ahead. Should more head-sail be required for fine weather, I would fit a running iron bowsprit.

To reduce the chances of the lower masts being crippled in action by

large shot, I propose to increase their diameter considerably, securing them with wire rigging. I show a plan of fitting them telescope-fashion, (Plate xxxii), the topmasts and topgallant-masts being in one, by which means they may be struck with great facility: they thus preserve the character of the "polacca," without its drawback of a continuous spar, which cannot be got down when riding in a heavy sea, this I think one of the imperfections of the tripod system. This description of mast will stand better, from the fact of the whole length being a continuous column, as all the masts have a common vertical axis.

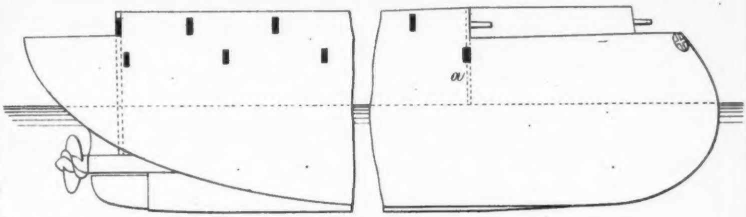
Figs 3 and 4 show the method of fitting the lower mast-head and topmast. The head of the mast left open on the after side so that the topmast and topgallant-mast when sent up "abaft all" may be pointed through the rigging funnel landed on the lower mast-head, the heel of the mast being secured in its place by cross-bars as shown, the mast-head being strengthened on the aft side by a vertical web.

A ship propelled by two non-fouling twin-screws (that can be raised or not, as may be required), which can bring her guns to bear at any required angle, will, I contend, be a more perfect fighting ship than the cupola-ship, and having over and above the advantages I have claimed, the power of firing two guns right ahead (or even crossing at 30 yards) at any angle of depression, a point unattainable in any cupola-ship I have yet seen designed. I beg to call your attention to this arrangement as shown in the model, (Plate xxxi.,) which though specially applied to the ship I propose, is, I conceive equally applicable to existing ships with a slight modification. In this arrangement, it will be seen that about forty feet abaft the stem, an armour-plated bulkhead (*a*) is run across the upper deck, extending to a sufficient distance along the side to cover the gun; this bulkhead is pierced with a port on each bow, through which two bow-chasers can be fired parallel with the keel, and, if necessary, crossing their fire thirty yards ahead of the ship. These guns can be depressed so as to strike an object close alongside. The space between the bulkhead and stem I propose to make cellular, with sides slanting from the top, or deck, so as to allow space for the bow-gun to be fired without injury to the bulkhead, the open space between the slanting sides and the side of the ship forming a fine weather head, the space enclosed between the slanting bulkheads being decked over, and divided into cells or compartments. This I propose to arrange as a head for bad weather and for hospital purposes, which I believe will be a great advantage in a sanitary point of view. In the event of these guns being required in chase, the cells immediately before the bulkhead may be filled with hammocks to afford additional protection. The vertica bulkhead on the upper deck aft which is immediately over that on the main deck, is pierced with three ports which admit of three guns being fired right astern and one on each quarter, the bulwarks abaft the bulkhead being fitted to lower. The armour-plated bulkhead on the main deck forward (*b*), shown by the dotted lines, is slightly curved at the point of junction with the side of the ship, so as to allow

Twin Screw Broadside Gun Ship.

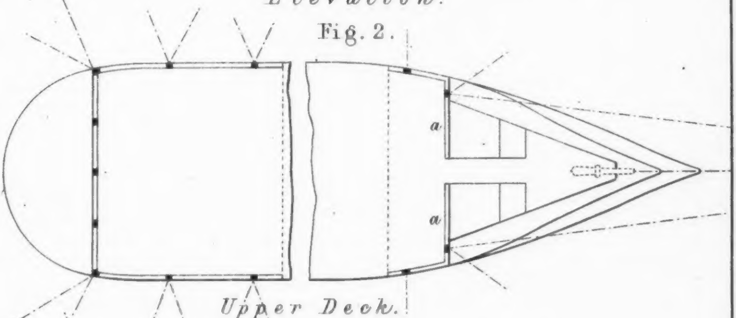
With new arrangement of Fore-body and of Bow and Stern Chasers.

Fig. 1.



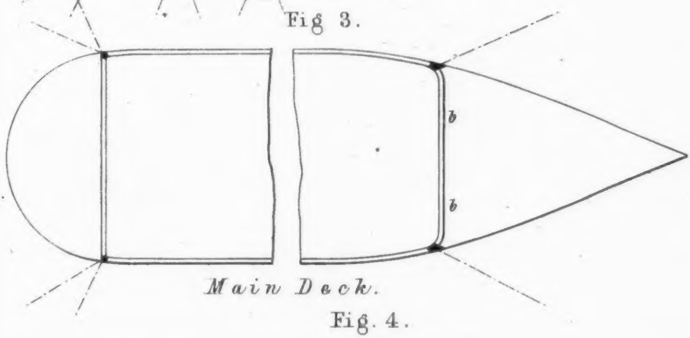
Elevation.

Fig. 2.



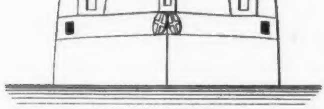
Upper Deck.

Fig 3.



Main Deck.

Fig. 4.



Bow View.

N.B. The dotted lines shew the Iron plated Bulkheads and Break of proposed Poop and Forecastle.

J.R.Jobbins

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Fig 1.

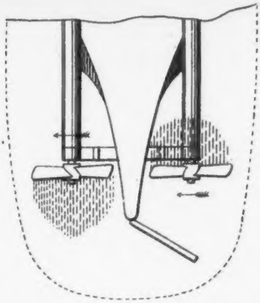
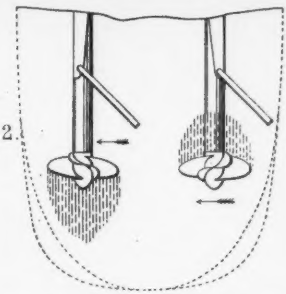


Fig. 2.



Bottom Plan of Vessels shewing Action of Screws and Rudders in Turning on Centre.

Fig. 3.
Elevation.

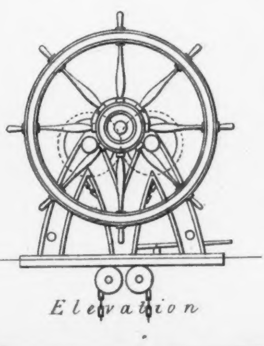
Plan at a.a.

Telescopic Mast.

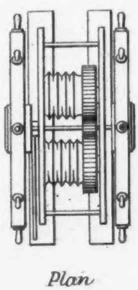
Plan at b. b.

Fig. 4.
Section.

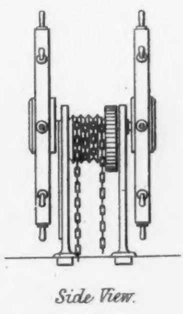
Symonds' Patent Steering Wheel.



Elevation



Plan



Side View.

J.R.Jobbins

the bow-gun to be trained forward, the port being pierced through it and the side, so that the gun may be readily fired at an angle of 22° with the keel. The external face of the port being only four feet wide (about the width of an ordinary port), no lowering gunwale is necessary. (The after bulkhead on the main deck is fitted in a similar manner, so as to fire a gun on each quarter.)*

The line of fire from this gun will cross that of the forecastle gun, when trained aft, at about 48 yards from the ship, and may be depressd so as to strike an object on the water at that distance.

It will be observed that the form of vessel, as shown in the models, is very favourable for laying on the armour plates, nearly two-thirds of which may be applied *without bending;* the curves of the bow and after section being of such a character as to reduce it materially even in those parts. This description of form is being adopted in France, and seems worthy of attention in the present state of the plate-bending question.

In all the designs I have exhibited I have kept in view the advantage to be derived from the adoption of *straight plates*, as they are not only more efficient but far less expensive.

I must beg you to understand that in the plans I have brought before you this evening I have not had the assistance of any naval architect. They are purely my own, based on the principles of my friend Mr. R. Roberts, whose system of disposing the material in iron ships is now again brought before you in Figs 1, 2, 3, and 4. (See Plate xxviii.) I must therefore claim your indulgence for any imperfection in the attempts I have made to delineate my plans, which, if found to contain the important elements I believe them to possess, may be perfected by that assistance which I hope to obtain from Her Majesty's government in bringing them to a practical issue.

Commander SYMONDS: I do not wish it to be supposed that I am finding fault with Mr. Dudgeon's method of applying screws, because for mercantile purposes it is sufficient; but it is more especially for war steamers that I am now looking at it. Most vessels, in fact all that have been built in this country, are thus fitted. You perceive that the shaft is led out of the quarter, through a pipe supported on a bearing, which bearing is in a bracket (Plate xxvii., Figs. 3 and 4). The screws are in this case about 2 ft. 6 in., or 3 ft. apart. The way that Mr. Roberts has proposed to fit them is, to do away with these out-rigger brackets, as I call them, and to connect the shaft to the counter with a strong web of iron, which may be splayed out, either above or below, to increase the strength, as may be required, as in Figs. 5 and 6. The way I have mentioned is the mode in which we prefer fitting them, viz., with two keels and two rudders, as in Figs. 1 and 2. By that means you observe that by the screws, coming from under the bottom, you are enabled to have a greater diameter of screw further under the ship than you would in the other case; and that not only is the trunk or pipe secured to the counter of the ship by this strong web, but it is also

* Since reading this paper I have altered the arrangement described, so that a chase gun may be used temporarily through a port immediately over the stem, as shewn in Plate xxxi., Figs. 1, 2, and 4 (this gun would be generally stowed further aft), thus three guns may be brought to bear right a-head without obstruction of any kind. I have also carried the deck over the head, further aft, as a topgallant-forecastle to cover the bow guns, and propose a poop deck for the same purpose, the foremost bulkhead of which is to be musket proof, and loop holed for musketry.—E.T.S.

secured by the keels underneath. Now, I think that the out-rigger brackets are likely to catch all floating obstacles, weeds, and other things that may be floating in a river.

The CHAIRMAN: The present boats that have been tried have only one keel.

Commander SYMONDS: Only one keel. I propose two, or to fit the one-keel ship in this manner—with a web connecting the pipe and the quarter instead of the brackets, as in Figs. 5 and 6. I consider that two keels will produce a far better result, as to speed, and will at the same time unquestionably protect the screw and rudder more from injury under any circumstances. As there are two screws, if one screw happens to be injured, the other screw is capable of taking the vessel considerably in excess of half the speed she attained with both, while she steers admirably, as has been proved, by the rudder being put over not more than three spokes. With regard to the screw, its application has this peculiarity in it, that the boss, instead of displacing water, as it now does when abaft the stern-post, is the same diameter as the trunk, and therefore the water already displaced by the ship closes on to this trunk, and comes direct to the blade of the screw, which I conceive—in fact, I am tolerably sure from practice and observation—will be an advantage. The method that I propose to lift them by, is shown in Plate xxviii. The bulk-head A, which I call the termination of the ship proper, runs across the ship, and another bulk-head runs across about 6 feet abaft it; and between those bulk-heads there are ways formed—slides in which the screw-shaft lifts. The short shaft of the screw has part of a cheese-coupling on it, which fits into a cheese-coupling projecting from the fore bulk-head, A. When the screw is required to be lifted, the flaps are opened, and the screw is completely housed. The flaps being shut, the ship is, to all intents and purposes, a sailing ship. Fig. 5 shows the stern of the "Warrior," as she is fitted at present with the single screw. Fig. 6 shows the "Warrior" fitted with two screws. The single screw is 23 feet diameter, each of the twin-screws being 15 feet diameter. You observe that the slides form the web which connects the trunk to the ship's counter; and that the screw, when housed, would be, not only well above the water line, but would be housed in the ship. When that is the case, I assume that the steerage, from what I have seen of those other screw vessels with single keels, will be as perfect in that ship as in an ordinary ship; whereas the same vessel, with the single screw lifted, the water passes through the aperture instead of impinging on the rudder, and reduces the steerage very materially.

The cellular system shown in Figs. 1 and 2 consists of bulk-heads running fore and aft the ship till they meet at either end parallel to the side of the ship, divided into cells of so many feet for coal bunkers or other purposes. This, we contend, is a far better arrangement for general purposes, and more especially for war ships, than having the sides made double; for in the event of one of the outer sides being perforated in the double side ship, as was shown in the case of the "Great Eastern" some time ago, there was no room to work. Now, in this ship here, whether she is large or small, there would be several feet; and by the old appliance of stopping or partially stopping the hole with a thrum-sail, the pump might be applied, the water falling out at a lower level, and the hole might be repaired. At all events, only one compartment would be filled as was the case in the "Keokuk." Several of her compartments were filled, but there was sufficient to keep her afloat until they had run her out of the harbour.

With your permission, although I have exceeded my time very much, I would call your attention to a drawing which I omitted before, which shows the method of turning with two rudders and two screws. Plate xxxii., Fig. 1 shows the "Flora," with her screws, one backing with the helm hard over. I contend it was not right to put it hard over, but still it was done. I think you will see that the vessel would have done better if the helm had not been put hard over. The backing screw is throwing the water forward, the rudder here keeping the water away from the screw. If you observe, in this vessel there is much greater area of resistance to turning than there would be in a vessel without the rudder and deadwood; and that in the case of Fig. 2 both the backing screw and the screw turning ahead are acting on the water without any interference from the rudders. I believe that in

practice we shall find, (and several gentlemen who watched these experiments with me believe the same), that the rudder is literally of no use after the first impulse is given in turning motion; that in going round, the better plan would be to allow it free play. Then, in this case, I think you will see, that the two rudders would certainly be less in the way of turning than the one, because even if you were to allow the single rudder free play, the motion of the ship to starboard would throw it across the screw and interfere with its action. The turning power you perceive will be greatly increased by applying the screws underneath; there will be less interference with the water coming to them than there would be if they were closer to the vessel as in the single keel

The CHAIRMAN: I am afraid the evening is so far advanced that it will be impossible to go into all the topics that have been raised by Captain Symonds. I would first say that I cannot at all concur in his opening remarks deprecating the criticisms that have been made upon his screws. I believe it is our business to criticise here, to try to find out the weak points in the harness; and that we cannot criticise too severely every scheme that is brought out, and if we find that it is imperfect, to say, it is not for the country to adopt it. Criticism is like the opponent of the athlete. His struggling strengthens his muscles, and gives him the means of developing the future element of success. I say this for the purpose of encouraging gentlemen, that they should not be discouraged by remarks of that sort; but we, without hesitation, should criticise what we think is deserving of criticism. Our object is to prevent anything from being adopted that is unworthy of being adopted, and that eventually may have to be rejected. It appears desirable for clearness to discuss the subject before us in detail. The first and main point of the lecture, as announced, was that of "the double screw." Perhaps gentlemen will kindly confine themselves to that in the first instance.

Commander SYMONDS: I assure you that the remarks with which I opened, were not at all with the view of preventing criticism, for I should rather court it; but there were such dogmatic assertions made by those who build screw steamers, that they were sufficient to drive one out of the field, if one had been disposed to be frightened.

The CHAIRMAN: We shall be happy to hear any remark upon the subject of the double screw and the position of the rudder. They are both new, and it is very important that they should be discussed.

Mr. BARRASS: A rudder referred to its first principles, is the short arm of a lever, of which the long arm is the ship, and the short arm of the lever turns the ship round by the resistance it meets in passing through the water; I cannot therefore conceive how by perforating the rudder and so lessening the area of resistance you make the rudder a better steering apparatus. It certainly lessens the resistance and thereby makes it easier to be turned round, but I cannot conceive how it can be a better instrument for steering. No doubt the fact that it would be easier to be turned round, has given the idea to those using such a rudder that it was an easier rudder to steer by, because it went round more easily. But I conceive the question should be, is it a more efficient instrument to steer the ship? I cannot see myself how it can be.

Mr. MACINTOSH: With reference to the steering qualities of the twin screws, I think the lecturer did not do sufficient justice to that part of the subject. They, in fact, form a Barker's mill, and must evidently turn the vessel round, independently of the rudder. With reference to the holes in the rudder, which Mr. Barrass finds fault with; there is a degree of friction the water has in passing through those holes, which would itself not only relieve the percussive blow of the sea, but at the same time they aid the rudder in steering more effectually, from the very fact that the fluid meets the perforations in a diagonal direction; so that, although the percussive blow is lessened, a rudder so perforated will I think effectually act as a good steering rudder.

Mr. SKELTON: No doubt the rudder, being perforated, moves easily; and, as regards the double screw, we know there were favourable advantages obtained a few weeks ago with these vessels of about 500 tons; but I am very doubtful if such advantages would be obtained with a vessel of 3,000 tons. In the first place, you would require to have the vessel built with the stern overhanging, similar to that of a

yacht. If you adapted the screw on long shafts, you would be liable to have those shafts strained, and, going into action especially, they would be liable to get damaged. Another objection might probably be met with in these double screws. Take, for instance, a vessel of 3,000 tons, and about 800 horse power, and a single screw 17 ft. 6 in. pitch, and she will have about six or seven, I will say eight, per cent. of slip. But if you were to build a vessel of 3,000 tons, with a double screw, you would require a longer stern, and, having the screws 8 ft. 6 in. pitch, you would increase the friction to about twenty-four or twenty-five per cent. It is well known with screw propellers that the longer you can get the arms, the larger the amount of area on them, the more speed you get; and the more you reduce them, the more friction you have, the more slip you get. No doubt, with a vessel under 500 tons burden, the double screw does turn her round quickly; but then she is a short vessel. But when you come to vessels of the "Warrior," the "Defence," or the "Resistance" class, you would not turn a vessel of that description with the double screw. I doubt whether they would turn round in so short a time as with the present system. I have no doubt there is some difficulty when the rudder is over, because they have not sufficient area on them. No doubt the hydraulic principle is suitable in smooth water, but it is not altogether suitable in a sea-way. As regards the fighting qualities of a ship, I consider the double screw objectionable. I know it has been a failure in America, and I know one vessel that has abandoned it. I do not know whether the results of these actions against the Southern forts have led to anything better. Looking at the application of the principle to ships of war, there is a very vulnerable point in those ships. Supposing you wanted to try the ramming principle, you need not have the cut-water of your vessel very strong to run into her stern and cut the ship in two, because it would take a very slight blow between those two tubes to sever them; but with the single screw there is very little chance of striking the stern so easily; the blow would glide off, and run into the upper portion of the ship; whereas, in striking at these double screws, it is nearly sure to catch one screw or the other. With regard to the remarks respecting the American iron-clads, it is a well known fact that the turret ships have been a failure. On account of the monstrous size of the guns they have to carry, on the batteries, they are not able to elevate them sufficiently high. The "Ironsides" was the vessel that was constructed with solid forged plates, and she got such a hammering for the first quarter of an hour or twenty minutes that she was obliged to withdraw. I have no doubt the double screws have several advantages, but I do not see much advantage from them in a fighting ship.

Mr. MACINTOSH: Will you allow me to make a further remark? This gentleman has spoken of the failure of the double screw. I am at a loss to understand how it could be a failure. You understand the principle of it. I have never seen it till to-night, but what I can see of the double screw, the propelling principle is absolutely nugatory while the screws are working in opposite directions; the whole power of the engines is employed to turn the vessel round as on a pivot. The propelling power of that vessel in a straight line is nugatory, and the greater the distance these screws are from the centre, the more effect they will have. The whole motive power is expended in turning the vessel; hence they give an advantage in pouring in broadsides, an advantage that I conceive no single screw can have.

Mr. SKELTON: No doubt there is an advantage there, but what an advantage it would be to pour in a broadside on the double screws.

Mr. MACINTOSH: They are well protected.

Mr. SKELTON: That I am very doubtful of. They can be protected to some extent; but, as regards fighting broadsides, I do not think there are many armour-clad ships will be fought broadside to broadside; they have found the stern is the weakest place. There is no difficulty in fighting an armour-clad ship; if you can get at her stern, there is no difficulty in punching her there. The single screw gives that advantage. As regards Captain Symonds' remark on the inclined surface on the bow of the vessel, I cannot exactly admit it as a principle to be adopted.

The CHAIRMAN: We will discuss the double screw first.

Mr. SKELTON: There is another plan of using the double screw—instead of working them vertically, to work them horizontally. If you work them horizontally, you may

fix them 24 or 25 feet from the ship, and no one can tell where the screw lays. It lays in the dead water of the ship. For instance, the floating fire-engine on the river, she works with horizontal screws, and when she is going on, scarcely any one knows where her screws lay, whether in the fore-part of the ship or in the aft-part. Now, they are converting the vertical principle into the horizontal principle in America at the present time. I should like to see the result in some of our heavy frigates. With regard to turning the ship, the screw is not always wanted for that; it is to drive the ship ahead. To turn her is no doubt an advantage sometimes, but it is not always required.

The CHAIRMAN: It is quite true, as regards the perforated rudder. I see the same difficulty that Mr. Barrass does. There is a definite angle, which gives a maximum effect—a definite angle to which, if you put the rudder over, which is easily calculated, it gives the greatest possible effect. Now, if you place this rudder at that given angle, you have a different series of angles; so that if you alter the angle of the rudder, and accommodate it to these orifices, you lose the effectiveness of that portion of the rudder. The analogy that is drawn between that and the Chinese vessels really does not exist. It is true that they have perforated rudders, but that is entirely for a different reason. They have immense rudders because they have no keel; they want immense rudders to keep them steadily on the course on which they have been placed. They have but a small gripe, but no keel, exceedingly round bottom, no stern post, nothing to prevent them turning round; consequently, in any sea or wind, if they had not the rudders perforated, they could not stand the strain they are subjected to. They have no lower pintle, the whole rudder turns on, and the whole strain is borne by the rudder head: therefore it is necessary to perforate the rudder, in order to relieve the rudder head from the enormous strain which would inevitably break it. The Chinese rudder has to act the part of the keel as well as to turn the vessel round; therefore the cases are not parallel. With regard to the double screw, it might be very effective, and I doubt not it is very effective in turning the ship round; but, as Mr. Skelton says, there are other points to be considered besides. Captain Symonds has told us that the diameter of the single screw is 23 feet; with the double screw it would be only 15 feet. Now, we can quite understand the difference of efficacy between the 15-feet screw and the 23-feet screw; and, as the previous experiments that we have had upon screws have shown, in proportion as you increase the diameter of the screw you increase the efficacy. Taking the conditions as pretty much the same, the weight the same, the displacement the same, the form of body the same, yet it has actually been found that you may increase the displacement, add weight to that ship; but, because you have increased the immersion of her screws, you get greater results. Here he is giving up that character which all experience has shown us to be a great advantage. These were part of the objections that were raised in the first instance. When certain results are given, they are results as far as they go, but they are not comparative results. Similar vessels with single screws have not been placed in contrast with her; for instance, in regard to the quantity of coal consumed to produce equal results. That is a very important point to be determined, before we can pronounce definitely that the double screw is a decided advantage. I have no hesitation in saying, that if we can get the double screw to do anything approximately to what the single screw does, it has a decided advantage, because it is a great advantage for coast defences and in narrow rivers to be able to turn. I have seen the immense advantage that paddles have over a screw in river work. I quite feel that the screw has advantages at sea, but I do not think those advantages at sea compensate for the difficulties and disadvantages of the screw in narrow waters. I think it is possible—it may be quite true—that as the single screw is placed in the centre of the vessel, it is less remote from the solid body of water upon which it has to act, and the longer arms may have been more effective because they reach out into the solid water. If by projecting each of the two screws further out into the solid water, you get the same result (and it does appear possible that that result will be arrived at), then it is a decided advantage. But I do think we ought to have comparative results—vessels similar in all respects, one with a single screw, the other with a double screw. I do not see any objection to placing the rudders before and under the screw. It is true it has

been found that the action of the screw throwing the water upon the rudder gave it considerable increase of power; but I feel myself, and I have always contended that it is an objection to have the rudder so far away from the turning point. Notwithstanding you have a short lever, I believe, as we often see on board ship, it is a great point to get near your work. I believe it is so with the rudder that it has more power; that the moment the action of the water is set up on the rudder, and the vessel begins to turn, she recedes away from that water which is acting to turn the ship, and the force is considerably lessened. If you shorten the distance, you shorten the rapidity with which she recedes from that water, and the action of the current of water is stronger in proportion.

Mr. Olrick, C. E.: I wish only to make a few remarks. Our gallant chairman has said that this is the place for criticism, but I think when statements are made entirely erroneous, that they should be contradicted from the same motives. Several remarks were made by the gentleman behind me (Mr. Skelton) that the friction would increase very considerably. That is the same objection that has been made in other societies against the double screw. The objectors entirely lose sight of the great gain there is, in connection with these screws, by using much smaller engines. It is a well-known fact among engineers that the smaller you make your engines, the more complete and perfect workmanship you can put into those engines.

The Chairman: I think by friction you meant "slip."

Mr. Skelton: I meant "slip."

The Chairman: It is to prevent confusion. The point is the difference of "slip" between the screw of small diameter and of large.

Mr. Olrick: In this case with these small screws, the engines that drive the screws are made to turn almost at the same speed as locomotives, that is to say, to turn a couple of hundred revolutions. Consequently, the pitch must be much finer, and it is a well-known fact, that with a fine pitch and many revolutions, there is much less "slip" than with a coarse pitch and slow working engines. Then, in either case of loss by friction and by "slip," there will be a great gain by these engines and by the double screw than there will be by the single screw. From many years' experience at sea myself, I can say that there are several points against the single screw. For instance, I have often had my cabin against the rudder post, and I assure you that the oscillation in the aft part of the ship is so enormous that I have sometimes not been able to sleep for hours, although I have been very tired from my watch. And as an engineer, I may say that the action upon the bearings and upon the afterpart of the ship has been such that if I had had time to watch that ship, I am sure I should find that by this time she would be entirely destroyed. Why that oscillation takes place I have never heard properly explained. But I have formed an opinion myself. The reason is, that when the top part of the screw goes through the water the water recedes; at the bottom part the water is much more solid; consequently, the screw turning one way, there is a tendency to force the ship over the other way; but, as the action is confined to the stern post and is merely momentary, when the blades pass the dead wood the oscillation arises from this cause. Now, as there is no stern post in a double screw the oscillation from this cause is entirely avoided. Likewise, there are four blades instead of two; and even with two blades the oscillation would be much less, as the smaller diameter allows the screws to be deeply immersed into solid water. Consequently there is a great deal of gain; as the destruction of the aft part of the ship is entirely avoided by this. In respect to the remark of the gentleman behind, that the large ships would be much weaker, he has forgotten entirely that Mr. Roberts and Captain Symonds have designed two stern posts combined with the aft part of the ship by a web. In that way they form a very strong beam. And in respect to expense, it would be probably not more than 50 per cent. of the present expense of forging a stern post. I have seen enormous forgings. The expense of doing it well is considerable; it is equal to that of the large shafts which we use for 1,000 horse-power engines. At Liverpool, where these large forgings are made, they never guarantee the shaft; they only give this security that they will forge another if the one supplied is not sound. The same has been the case with the stern post; they have been forged on that condition, that if not sound they will give another in its place. That is entirely avoided

by the kind of stern post which Mr. Roberts has designed. It is rivetted up from heavy plates, and that is simply boiler-maker's work, which can be done at 50 per cent. less cost than forging a stern post. With reference to the non-fouling properties of Mr. Roberts' screws, I can only say that I have tried every possible means to foul these screws with ropes, chains, tackle of all descriptions, because I did not believe in it myself; and after many experiments, I found it was entirely impossible, and I gave it up; and according to my experience I certainly may say it is a fact that the screw is non-fouling.

The Chairman: Will you name the ship?

Mr. Olrick: It was not in a ship, but with models of a larger size of screw. In respect to the four-blade screw, there has often been found a greater loss where the screw passes the stern post, that is to say, less efficiency, than in this case where there is no stern post to pass. Consequently the four-blade screws will be more effective than a single double-blade screw. That is the reason why the twin-screws, although they have not actually been compared with the single screw, give more efficiency, because the stern post has not to be passed every turn; and as in this case it would be eight times, if there were stern posts, we can easily account for the superior results those small ships have given compared with the single screw of equal area; because it does not increase in proportion as the diameter; but it increases in proportion as the area; and that is as the square of the diameter. Therefore, I think we can fairly rely upon those results, although they have not been compared with the single screw.

Rear-Admiral Sir Edward Belcher, C.B.: I wish to make one or two remarks—first, as to the size of the screw giving greater velocity. Facts are better than theory. I was on board a steamer that started from Neath Abbey to go to Bristol. She lost one of the arms of her screw. On her previous trip she attained a velocity of eleven knots. The engineer "shut on" the blade of one of the fire-shovels, and she then attained twelve knots velocity. In the cases of the "Hebe" and "Kate," I was on board both vessels, and made the observations, as well as noting the revolutions, during the trials. They made 127 revolutions. The moment I put my foot on board the "Hebe," I observed immediately to Mr. Dudgeon, "You have overdone her; your screws are too large; the vibration is too great, and the tendency of the bow to waver has destroyed your velocity." He said he knew it thoroughly well, and was going to cut off six inches. I do not know whether she has been tried since.

Commander Symonds: Yes, she has, and she has gained a knot more.

Sir Edward Belcher: Therefore, you see the necessity of not taking these theories for granted, but of going on board the vessels, and trying for yourselves what they will do. As regards the position of these screws, Captain Symonds distinctly told you that in the "Flora" and these vessels where the screws are placed so near the water's edge, any vessel running at them would destroy them. But if you take the perpendicular from *his* models, and take the distance between the gripe of any vessel going at that screw, you will see it is an utter impossibility that her gripe can touch; and when the upper part of the enemy strikes the solid projecting part of the vessel, the vessel will yield and give way. She must destroy the upper part of the vessel before she can touch the screw. With regard to the steerage, you find with good boatmen, who can scull well with a long oar, that the slightest agitation of the wrist will drive the vessel ahead with immense velocity—she will go ahead like an eel; but if you put a man in who is not apt, who does not understand sculling, the boat rolls, her nose will fly from side to side, and her velocity is so much impeded, that any man with a single hand with the oar will beat the man who is using enormous strength. So I take it to be with the screw. If you have a large screw, which causes immense vibration, first driving the vessel's stern from one side to the other, or rather her bow from side to side, you certainly lose velocity, and you may even destroy your vessel by the vibration.

The Chairman: Perhaps Captain Symonds would like to reply to the observations that have been made.

Commander Symonds: I have very little to add on the subject of the power of the two screws to what has already been said by Mr. Olrick and Sir Edward Belcher.

I am rather surprised at Mr. Skelton saying that these screws are liable to damage, because really my claim to their immunity from danger has been borne out to a very great extent. As Sir Edward Belcher remarked, if you take a perpendicular from here (pointing), you find the screws are something like eight or ten feet clear of any vessel's bows striking them. It is one of the peculiarities of fitting screws underneath, in contradistinction to having them fitted with the single keel. As to the additional friction which was mentioned, and any loss being attained by the smaller diameter, certainly the experiments in all three vessels of Mr. Dudgeon have proved the very reverse. There is this one great advantage in the two screws, which is, that you immerse them more deeply, that they are literally working under a greater head of water, and therefore they have not that liability to lose, by centrifugal action, or by being lifted out of water, which a larger screw near the surface has. Again, it has been, I think, proved satisfactorily in these vessels with small fine-pitch screws that there is less slip (unless the calculations that have been made are exceedingly incorrect), that there is actually less slip due to these two small screws with fine pitch, driven at a great number of revolutions, and far less vibration, than there is to a larger screw; and, unquestionably, the screws being taken to the water, in the case of the twin-screw, instead of the water being brought to the screw, as in the case of the single screw, you do get your screws to act in better water, I will not say in denser water, but in better water, and in a better position than you do in the case of the single screw. I should be very sorry at this period of the evening to go into the theoretical part of the matter. I do not profess to be thoroughly conversant with all the theoretical points; neither do I believe in many, for I find them opposed to practice. I have been excessively anxious to find out whether the plan was good or not, and I have seen the result in these vessels, and they have proved to my mind all that I have hitherto seen and believed. With respect to their liability to foul, I may say the only wish I have is that they may be tried. As Captain Fishbourne very properly remarked, it may be different in a large screw from what it is in the model; but certainly all the experiments that have been tried in models have shown, and I have clearly demonstrated to engineers and others in these experiments, that there was an impossibility of fouling; and, if so, I think they merit the praise I have claimed for them. There is no doubt that in such vessels as I have described to-night, and as we have had described in the papers, a great deal of the want of success was attributable to fouling; and that if in such vessels you can get screws that do not foul, although you may have a loss of speed, which I very much question, still it will be a very great advantage. With regard to the rudder on the Chinese principle, I think what Captain Fishbourne said, rather tended to prove my position than otherwise. He says these enormous rudders are perforated because they are not really manageable without the perforations.

The CHAIRMAN: What I say is, that the power of the rudder is not increased by the perforations. That is not the argument with the Chinese. The Chinese are obliged to have a large rudder, because they have no keel. In order to retain the vessel in a straight course, it is necessary to have a given quantity of flat surface. Having no keel, they must have it in the rudder.

Commander SYMONDS: It is a fact that if the Chinese rudders were not perforated they could not get them over to the requisite angle to steer them. I believe that is the fact. It was the case with the "Glatton." The "Glatton's" was in the same position as my rudder—it did not go below the ship's bottom; and I consider the "Glatton's" experiments are a more satisfactory proof than those I have adduced in China. It appears to me, as I said before, that these holes admit of the water passing laterally, that there is a free passage, reducing the lateral pressure, and that its series of inclined surfaces, al at the same angle, are brought in contact with the water at a greater angle than the plain surface of the rudder would be, and that each of these surfaces forms an additional obstruction. It has, I think, been proved lately, that it is to the obstruction the rudder offers that the amount of power is due, For instance, in that rudder of Mr. Lumley's, it is not the angle at which the whole is got over; it is, as it were, the water that is massed up by the after-joint of the rudder. It appears to stop the water in a mass.

Mr. BARRASS: It simply brings half the rudder against the water at a greater angle. I forgot to state in my observations, that when you do get the perforations at a certain angle the water does not impinge against them at an angle, and so, as it were, entice the vessel round. That is not the principle of the rudder. The rudder is the short arm of a lever, of which the long arm is the ship; and if you make perforations you lose the resistance by which the vessel is pulled round.

Commander SYMONDS: I take the "Glutton's" rudder as perhaps the strongest point. There was a vessel that came out of Malta hardly able to steer. By accident I met the person who made her a new rudder. He added about one-third additional surface to the rudder, and perforated it with five-inch holes, circular instead of diamond shape, and the vessel steered very well afterwards.

The CHAIRMAN: The question is just this: would not a smaller quantity added, without any holes, have produced the same result?

Commander SYMONDS: No, it does not.

The CHAIRMAN: Was it proved?

Commander SYMONDS: It was proved there, but on no other occasion that I know of; but I have discussed this point with many others.

The CHAIRMAN: That is just the point at issue.

Commander SYMONDS: You cannot get the rudder, without perforations, over so quickly.

The CHAIRMAN: Granted; but the question is as to steering. Clearly, you cannot get it over so quickly; nobody questions that.

Commander SYMONDS: Well, be the cause what it may, the effect is actually better. I do not profess to know more of the cause than I have explained. I assure you that in bringing these plans, the rudder among others, before this meeting, it was perhaps as much to learn from discussion what really are the causes of the several effects which I have witnessed lately. At this hour I cannot detain you any longer in the matter. I should have been very glad, indeed, if we had had Captain Coles here to have gone into some of the points of his cupola ship which I mentioned. I still retain the opinions I have advanced as to the advantages of the broadside ships, for sea-going vessels at all events: and I cannot say that my faith has been at all shaken in the two-screw system from what I have heard to-night from that gentleman from America. I have really heard from so many Americans the very reverse of what he has said, that my confidence remains still unshaken as to what they have done in America; and the best proof is that they are building most of the vessels there with two screws, finding one is useless for manœuvring purposes. We shall have very shortly more vessels built by Mr. Dudgeon with the twin-screws, of a larger size than those which he has built before. I hope to have the pleasure of bringing them to your notice; and I trust that you, or some others in this Institution, may see these experiments and judge for yourselves, and you will find, I believe, that they will bear out all that I have claimed for them. I cordially concur with what the Chairman said as to experiments. I do not wish, I should be very sorry, to have the thing received without experiment, because I am perfectly confident that the more experiments are made with the twin-screws the more they will prove their great advantage. I am quite satisfied of that. And when I say so, I am borne out by several eminent officers of the navy, engineers, and others, who have been on board these vessels with the full intention of pulling the system to pieces, and finding fault wherever they could. I can safely say, and Sir Edward Belcher will agree with me, that everybody has left those vessels more firmly convinced than ever of the advantages of the system, both as to the propelling effect, and the wear and tear of engines, they being lighter aud more adapted for sea-going vessels. Then, the accounts of the quantity of coal expended, and of their sea-going qualities are very favourable, as compared with the single screw.

The CHAIRMAN: I think we ought not to pass a remark that has been made, drawing a contrast between theory and practice, as if they were in opposition. I contend that all correct practice and all correct theory are one. It cannot be otherwise:

"All chance direction which thou canst see
All Discord, harmony unknown to thee."

We are very much obliged to Captain Symonds, and I am sure you will allow me to give him our thanks for the very clear way in which he has enunciated his views, and in which he tended very much to show that there was no disparity between theory and practice; and he gave us a very clear statement of the reasons why the practice shown was in accordance with theory.

LECTURE.

Wednesday, May 27th, 1863.

CAPTAIN EDMUND PACKE, late R.H.G., in the Chair.

ON THE HISTORY OF THE BAYONET.

BY CAPTAIN SIR SIBBALD DAVID SCOTT, Bart., F.S.A.

IN bringing under notice the subject of the bayonet, I wish to confine myself as strictly as possible to the *history* of that weapon, its rise and progress, without indulging in any speculations as to its future. Nor shall I venture to offer any suggestions for its improvement, either as to construction or management. The subject under such treatment must necessarily be devoid of any practical advantage; I must trust, therefore, to the interest attached to the history of a weapon which has played so conspicuous a part in the armies of all civilised nations, in order to compensate for this deficiency.

The bayonet, as a military weapon, was an invention, or, more strictly speaking, an adaptation of the 17th century; for after all it is nothing more than a dagger; the dagger, again, is little more than a knife, and that was so useful and portable a weapon, that under the various designations of knife, dagger, misericorde, or poniard, it was seldom absent from the person.

The word "dagger" is mentioned as early as the 12th century. In a Latin statute of William I. of Scotland, cap.23, we find it enjoined that "Every man shall have a knife (*cultellum*) which is called dagger." In a treatise entitled "The Military Art of Training," published in 1622, the dagger is strongly recommended as "the necessariest weapon that belongs to a souldier," for six special reasons:—"1st, for ornament; 2ndly, for use in the *mêlée*, that when he cannot use his sword, he may doe good with his dagger; 3rdly, if it should come to a private combat, and a sword should break; 4thly, for despatch of the vanquished; 5thly, for tying a horse in an open field, where there is neither bush nor hedge; and 6thly, for the punishment of offenders,

for a captain or inferior officer that only draws a dagger, may appease a sedition."

The question now to be disposed of is, when was this knife or dagger first applied to the fire-arm, so as not only to give it a defensive character, but to invest it with a second offensive power—probably more effective than the first.

In the 16th century the musket first appears. It owed its introduction to the inconsiderable effects produced by pieces of small calibre. It was a long, heavy, cumbrous weapon, carrying balls of greater weight than any other fire-arm then introduced. It was invented abroad—in Spain or Italy. The English of mediæval times were not an inventive people; I am not aware of a single implement in the art military that can be claimed as a British invention. Brantome says that the Duke of Alva was the first who introduced muskets in the armies of the North, when he assumed the government of the Spanish provinces of the Low Countries in 1567, and organised those bands of musketeers, who became so terrible to the Dutch.* With us the adoption of them, according to British precedent, was some time after their introduction in the leading foreign armies. We hear of them in 1577, when Queen Elizabeth was at length constrained to despatch an auxiliary force to the Dutchmen fighting obstinately for their liberty.†

We shall see what an encumbered man the poor musketeer was. First of all, the barrel of his piece was to be four feet in length, and the bore capable of receiving bullets, whereof twelve weighed a pound.‡ In consequence of its length and weight, it could not be fired without a support, and hence originated the rest, or *fourchette*, which was a staff the height of a man's shoulder, with a fork or semicircle of iron at the top to receive the musket, and a ferule of iron at bottom to steady it in the ground. On a march, when the musket was shouldered, the rest was either carried in the right hand, or hung from the wrist by a loop and trailed. Then he carried his coarse powder for loading in a flask, his fine powder in a touch-box, together with moulds, worms, screws, rammers, and priming-iron, while in his hand was his burning-match and his rest; and after he had fired, he, perhaps, had to draw his sword to defend himself. Musketeers were, however, relieved from wearing defensive armour (as they were not intended for close fighting) with the exception of an iron helmet, the weight of which alone would frighten a modern, even if he had nothing else to carry. In fact, it required a strong man for the place, and therefore Markham, a military writer of the 16th century, observes, that "the squarest and broadest will be fit to carry musquets;" and another contemporary author, Sir J. Smith, writes that "it doth behove musquetteers to be strong and puissant of body, without sickness, achs, or other impediments." Round about his waist was wound his provision of match, which was a thin coil of rope, made of

* Hommes illustres et Grands Capitaines Français.

† Brief Discourse of the Spanish Discipline in War, by Sir Roger Williams. 4to. 1590. Also Oldys's Life of Sir Walter Raleigh. I. 25.

‡ Art Militaire, by Sir Thomas Kellie. 1621.

cotton or hemp, spun slack, and boiled in a strong solution of saltpetre, or in the lees of wine. One can readily imagine the inconvenience of having to carry about a coil of rope with both ends ignited. Its propinquity to the powder was not encouraging, and we read that sometimes fire-arm men carried their store of powder loose in their pockets.* This danger of the lighted match did not, however, always exist, for the rain and the damp often extinguished it, and the musketeer, or arquebusier, found himself powerless, so that it must often have become a question which should go off first, the man or his piece.

The bullets were kept in a bag, and the musketeer was ordered, when in action, to keep four or five of them in his mouth, so as to be ready for loading. This was considered his proper status, so that it was one of the stipulated conditions that troops who had capitulated should march out with the honours of war, namely, "with lighted match, bullet in mouth, drums beating," &c.

Not only was the musketeer a heavily weighted man, but his energies were further taxed by an amount of training to which the modern manual and platoon would be a mere joke.

In the "Souldier's Accidence,"† it is stated, "the postures which belong to the musket are 40 in number, and are to be done 5 standing, 3 marching, 18 charging, and 14 discharging." "And after all," sensibly observes Sir Thomas Kellie, "all this multitude of postures, in service, are reduced to three: make readie, present, and give fire."

Although it is not to be supposed that the musketeer went through the forty postures in the field, still, with every exertion on his part, the process of loading was necessarily very slow before the invention of the cartridge. Sismondi says that it took a quarter of an hour to charge a musket.‡

It was calculated that "every archer might shoot six arrows within the time of loading one musket," so that taking moreover into consideration the weakness of the powder in those days, it was no wonder that the use of the bow and arrow was so long preferred, and that the adoption of fire-arms was so tardy.

Ever since the invention of the musket, all sorts of contrivances had been proposed to defend the musketeer whilst loading. One plan was to arm the rest with a blade projecting outwards to ward off the attack of cavalry;§ this does not appear to have answered. Another, and which was adopted and used for a long time, was what was called "Sweynes feathers." The origin of the term is somewhat obscure; the defence consisted in a couple of stakes five or six feet long, to be carried by the musketeers, and to be stuck into the ground in front of them, after the manner of chevaux-de-frise. General Monck, afterwards Duke of Albemarle, in his observations upon military and political affairs, printed in 1671, recommends the arming of musketeers and dragoons with muskets having swine-feathers, with the heads of rests fastened to them.

* England's Trainings, by Edward Davies. Pub. 1619.

† By Markham. (In Library of Royal United Service Institution.)

‡ Hist. des Rep. Ital., ix, 341.

§ Turner's Pallas Armata, p. 167.

These stakes were carried by musketeers and dragoons in our armies until the 17th century, in fact, until superseded by the bayonet. Another scheme was, that the musketeer should carry a pike in addition to his musket. Pikes were then 16 feet long; this was afterwards substituted for the half-pike. There is a specimen of a musket and pike combined in the armoury of this Institution. It was probably an experiment only, and not adopted in the service.

In the reign of Elizabeth, the English infantry was divided into fire-arm men, archers, billmen, and pikemen. We may mark how gunpowder was, not *silently*, but gradually making its way. The quota of archers grows smaller and smaller, and billmen disappear altogether after this reign. In a levy of 600 men, in 1587, "shott and pikes" are only ordered to be provided. Prince Maurice of Orange thought so highly of the pike, that he divided his men half into pikemen, and half into musketeers. Lord Orrery, in his "Art of War," A.D. 1677, says, "our foot are generally *two-thirds* shot and *one-third* pikes;" and this brings us to the period when the musketeer and pikeman were to be merged into one and the same person, and the firelock, after having been discharged, was to do duty for the pike.

In the memoirs of De Puységur, we find what, I believe, is the first recorded notice of the *military* bayonet. I say *military* bayonet advisedly, for reasons which will appear directly. In chap. 8, on "L'ordre que doit tenir une Armée pour passer une Rivière," the author writes, "When I was in command at Bergues, at Yprès, Dixmude, and Laquenoc, all the parties that I sent out, crossed the canals in this fashion. It is true that the soldiers did not carry swords, but they had bayonettes with handles one foot long, and the blades of the bayonettes were as long as the handles, the ends of which (*i.e.*, the handles) were adapted for putting in the barrels of the fusils, to defend themselves, when attacked, after having fired."* This relates to the year 1647.

Now, although this may be, as far as we know, the first written account of the bayonet being used as a defence in war, Puységur does not mention the circumstance as though there was a complete novelty about it. He states simply, "Les soldats avoient des bayonettes." The fact is, that the bayonet was not a new invention at that time. In Cotgrave's Dictionary, first published in 1611, we find, "Bayonette, a kind of small flat pocket-dagger, furnished with knives, or a great knife to hang at the girdle, like a dagger." In the 4th volume of "*Le Passé et l'Avenir de l'Artillerie*," (produced by Colonel Favé, on the plan of the Emperor,) there is a transcript of a proclamation of Louis XIV., in 1660, wherein the King desired to rectify certain abuses in the carrying of arms, the preamble contains the following statement:—"La fréquence des accidents qui arrivent journellement par l'usage des baïonettes et couteaux en forme de poignards qui se mettent au bout des *fusils de chasse*, ou se portent dans la poche, et par le port et l'usage des pistolets de poche, nous obligé d'y pourvoir," &c. (p. 16.)

* Mémoires de Jacques de Chastenet, Chevalier, Seigneur de Puységur. Paris. 1747.

Thus, we learn that before the year 1660 (and it may have been very long before), down to our own times,* the plug-dagger has been in use for hunting purposes. Some of the earliest plug-daggers, moreover, are of a rich character, and others are ornamented with hunting subjects; some of them have a saw on one edge, very useful for forest arms, but out of place for a war bayonet.† Puységur's soldiers may have been the first who applied it to the more serious office of military defence.‡

Now as to its name. Bayonne was at an early period renowned for its iron works and cutlery. This, at first sight, would appear the natural source of its nomenclature, and this has been generally conceded. Ménage in his Dictionary, published in 1694, has, "Bayonette, sorte de poignard, ainsi appelée de la ville de Baionne;" and Voltaire has immortalised the circumstance, be it correct or not, in the "Henriade:"—

> "Cette arme, que jadis, pour dépeupler la terre,
> Dans Bayonne inventa le demon de la guerre."

But now comes a difficulty. Cotgrave's Dictionary, in 1611, gives us, "Bayonnier, an arbalestier, a crosse-bowman, also a crosse-bowmaker." And in the "Glossaire de la Langue Romane," of Roquefort, the word is again explained as a cross-bowman. It is difficult to perceive the affinity between a cross-bowman and the city of Bayonne, and it does not seem likely that a cross-bowman should be distinguished by the knife, and not the cross-bow. The word Bayonne is said to be a compound of two Basque words, *baia* and *ona*, good bay or port. It may be said that the cross-bowman was armed with a knife made at Bayonne; then those dictionaries should have stated the fact. They appear to have been puzzled about it. "Ce mot," says Michelet, "*semble* venir de Gascogne."§

A lower ridge or projecting buttress of the Montagne d'Arrhune, in the Pyrenees, is called "La Bayonnette." As a reason for this name it is stated that a local tradition exists, that at this spot was first extemporised the defence of the bayonet by some Basques, who being assailed by Spaniards, and having exhausted their ammunition, seized the idea of thrusting their long knives into the muzzles of their fire-arms, and by this means defeated their antagonists.‖ But were this circumstance authenticated, it would not bring us any nearer to the etymology of the word.

* Mr. Akerman states in a note to his paper on bayonets in the Archæologia (vol. xxxviii), that Mr. Bernhard Smith informed him that when he was at Rome in 1835, it was the fashion to have plug-shaped handles for the knives used in boar-hunting, so as to fit into the muzzle of the rifle.

† Specimens of some of these were kindly submitted for inspection at the Lecture, by Captain Arthur Tupper and by Mr. R. T. Pritchett, F.S.A.

‡ Maréchal Puységur recommends, in l'Art de la Guerre (1, 220), "that all soldiers, instead of swords, should carry *couteaux de chasse.*"

§ Dict. de la langue Françoise, 1759.

‖ Vide *Esquisses et Croquis Militaires*, par Becherelle, 1852.—The ridge of *La Bayonnette* was stormed and carried by the Allies in 1813, before they gained the Arrhune.

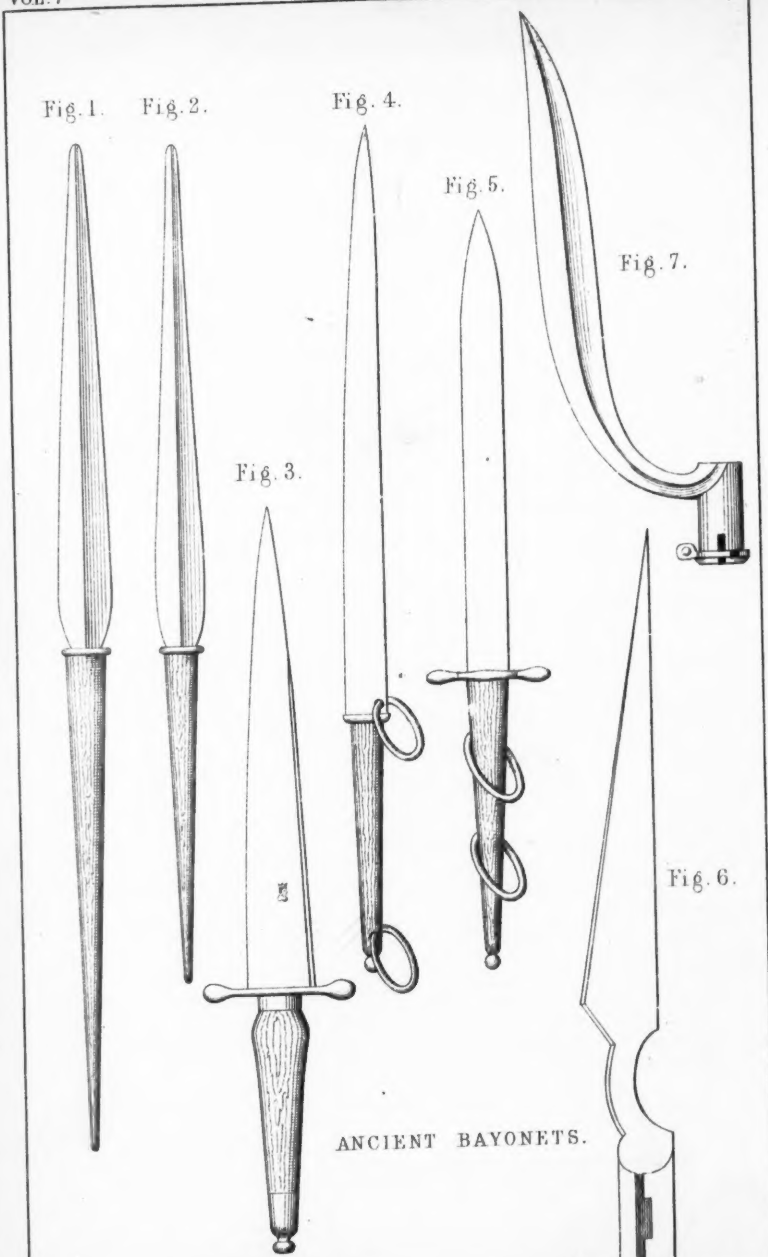
Notwithstanding the obvious advantage of the bayonet as a military weapon, it appears for a time to have been utterly neglected. Sir James Turner, writing in 1670, thus recommends its adoption:— "When musketeers have spent their powder, and come to blows, the butt-end of their musket may do an enemy more hurt than those despicable swords which most musketeers wear at their sides. In such medleys, knives whose blades are one foot long, made both for cutting and thrusting (the haft being made to fit the bore of the musket) will do more execution than either sword or butt of musket."

In a treatise on "English Military Discipline," published by Robert Harford, in 1680, we obtain a description of the bayonet, and also the date of its introduction here. He writes, "The bayonet is much of the same length as the poniard (12 or 13 inches); it hath neither guard nor handle, but onely a haft of wood, 8 or 9 inches long. The blade is sharp-pointed and two-edged, a foot in length, and a large inch in breadth. The bayonet is very useful to dragoons, fusiliers, and souldiers that are often commanded out on parties; because that, when they have fired their discharges, and want powder and shot, they put the haft of it into the mouth of the barrel of their pieces, and defend themselves therewith, as well as with a partisan." He goes on to observe, that pikemen are useless for advanced posts, where, in order to give the alarm, it is necessary to make a noise. "These reasons," he adds, "and many others, have led to the giving this year (*i.e.*, 1680) to some musqueteers, bayonets to fix in the muzzles of their pieces when attacked by cavalry, thus having the effect of pikes, the use of which will, ere long, no doubt, be abandoned." We have, up to this point, heard of two descriptions of bayonets, Puységur's, whose blade and handle were of equal dimensions, each a foot long (Plate xxxiii. Fig. 1), and Harford's, whose blade was 12 or 13 inches, and handle 8 or 9 inches long (Fig. 2). In Mallet's "Travaux de Mars," pub. in 1685 (a copy of which is in the library of this Institution) there is an engraving of the bayonet then in use, similar to this last one.

In the following year, the form of the bayonet appears to have been somewhat changed, and in this country, at least, an uniform or regulation pattern to have been adopted. There is one preserved in the Tower armoury, which bears this inscription on its blade "God . Save . King . James . 2 . 1686." A specimen of what was the common plug-bayonet (Fig. 3) is in our Museum, and many are to be seen in the Tower armoury, although 2,025 were consumed in the fire at that fortress in 1841.* Many decorate the walls of the Guard Chamber at St. James's Palace, and at Hampton Court.

This new species of arm was found very effective, and ultimately put pikes *hors de combat*. It took some years to effect this, so naturally do men seem averse to lay aside an old weapon—in England, perhaps, remarkably so—pikes were not discarded from the British service in 1706.

* This information is derived through Mr. John Hewitt, for whose valuable assistance I feel greatly indebted.



ANCIENT BAYONETS.

J.R.Jobbins

In 1671, a corps was raised in France, armed with fusils and bayonets, the latter weapon being carried for the first time in a sheath alongside of the sword.* This was the regiment of Fusiliers, afterwards called LE REGIMENT ROYAL D'ARTILLERIE, and the special duty which was assigned to it, was the protection of the guns of the artillery. In England, the example of France was followed, as was our wont, but, in this instance, pretty quickly. In the next year, a warrant was issued by Charles the Second, the original of which is preserved in the records at the War Office:—

"Charles R. April 2, 1672.

"Our will and pleasure is, that a Regiment of Dragoons which we have established, and ordered to be raised in Twelve Troopes of four score in each besides officers, who are to be under the command of Our most deare and most entirely beloved Cousin Prince Rupert, shall be armed out of Our stores remaining within Our office of the Ordinance. * * * The souldiers of the several Troopes foresaid, are to have and carry each of them one match-locke musquet, with a collar of bandaliers, and also to have and carry one *bayonett* or *greate* knife," &c.

"By His Majesty's Command,

(Signed) "ARLINGTON,"

"To Sir Thomas Chichely, Master-General of the Ordnance."

The introduction of a lighter fire-arm, the fusil, would render the bayonet far more effective. The old unwieldy musket, even when armed with the bayonet, was very unequal to cope with the comparatively light spear or pike. Our first regiment of Fusiliers (the 7th), was not raised till 1685, and its original special duty was also—like the French one—the protection of the guns, and it was provided with bayonets.†

Great as was the advantage of being able to arm the musket or fusil against a surprise, the loss of its fire, while plugged in the muzzle by the bayonet, was, of course, a serious one, and this led to a contrivance whereby the soldier could discharge his piece and retain his bayonet fixed.

The Maréchal de Puységur (son of the Puységur mentioned before), in the "Art de la Guerre" (tome i, p. 220), says that he "had seen a regiment, before the peace of Nimeguen, in 1678, which was armed with swords without guards, but in lieu thereof a brass ring, and another at the pommel (Fig. 4). Through these the barrel of the fusil was passed. This admitted of the same effect as the socket-bayonet of the present time."

* Daniel, Hist. de la Milice Françoise, Tom. ii, p. 422. (Liby. Royl. Un. Ser. Ins.)

† "Our Royal Regiment of Fusiliers to have snap-hance musquets, strapt, with bright barrels of 3 feet 8 inches long with good swords, cartouch-boxes and BIONETTS." King James II's orders for arming the Royal Fusiliers.—Cannon's "Records."

The immediate cause of the loss of the battle of Killiecrankie was the impossibility of fixing the bayonets in time to meet the impetuous onset of the Highlanders. In Mackay's Memoirs, for the year 1689, he says, "All our officers and soldiers were strangers to the Highlanders' way of fighting and embattailing, which mainly occasioned the consternation many of them were in, which, to remedy for the ensuing year, having taken notice on this occasion that the Highlanders are of such a quick motion, that if a battalion keep up his fire till they be near, to make sure of them, they are upon it before our men can come to their second defence, which is the bayonet in the musle of the musket. I say, the General (Hugh Mackay) having observed this method of the enemy, he invented the way to fasten the bayonet so to the musle without, by two rings, that the soldiers may safely keep their fire till they pour it into their breasts, and then have no other motion to make but to push as with a pick."*

The merit of this contrivance cannot, however, be claimed for General Mackay, as we have just seen. The peace of Nimeguen was in 1678, and the battle of Killiecrankie was fought eleven years after—namely, in 1689.

The experience gained of the characteristic impetuosity of the Highlanders in attacking with their claymores was not thrown away; and, in 1746, the Duke of Cumberland gained much credit by the success which attended the instructions which he issued at Culloden, that his soldiers should direct their bayonets each to his right-hand man of the enemy. The effect was that, when the swordsmen lifted up their right arms, they laid bare their breasts to the bayonets. In notice of this device, a cotemporary writes:—"The sword and target which the Highlanders were used to wield and brandish, with savage cries, have proved but feeble arms against the bayonet in the hands of stout and resolute men. The instruction given to the soldiers will doubtless be entered in the books of discipline as proper against sword and target."†

The improvement of the ringed bayonet was not generally or quickly adopted; for in an English manual, of 1690, the fusil of the grenadier has the plug-bayonet, as before. Grose mentions an anecdote, which he states was communicated to him by Lieutenant-Colonel Christopher Maxwell, of the 30th Regiment of Foot, who had it from his grandfather, formerly Lieutenant-Colonel of the 25th Regiment of Foot. It is to this effect:—"In one of the campaigns of King William III., in Flanders, in an engagement, the name of which he had forgotten, there were three French regiments, whose bayonets were made to fix after the present fashion—a contrivance then unknown in the British army. One of them advanced against the 25th with fixed bayonets. Lieutenant-Colonel Maxwell, who commanded it, ordered his men to screw their bayonets into their muzzles, to receive them, thinking they meant to decide the affair point to point; but, to his great surprise,

* "Memoirs of the Scottish War," p. 52. 4to. Edinb., 1833. See also Macaulay's Hist. of England, iii, 371.

† "Gent. Mag." for May, 1746, vol. xvi, p. 244.

when they came within a proper distance, the French threw in a heavy fire, which for a moment staggered his people, who by no means expected such a greeting, not conceiving it possible they could fire with fixed bayonets. They nevertheless recovered themselves, and drove the enemy out of the line."*

The story may or may not be true, but, on such questionable authority, no reliance can be placed on it. I have in vain endeavoured to test its accuracy. The history of the 25th is a very interesting one. It is not published in Cannon's Records, but I have had access to a MS. account of it; and it appears that it was raised in two hours, in 1688-9, and was shortly afterwards sent to Flanders, where it took part in the engagements of the war. No mention, however, is made of any affair like that above, nor could I find the name of Lieutenant-Colonel Maxwell as being in command of the regiment. The Army Lists do not commence earlier than 1741. The name of Christopher Maxwell appears in the Army List of 1782, having succeeded to the lieutenant-colonelcy of the 30th in that year. He entered that regiment as ensign in 1755.

The ringed bayonets continued in vogue for a considerable time. We learn from Grose that two Horse Grenadiers rode before the coach of Queen Anne, with their bayonets fixed by means of rings.† (Fig. 5.) Even later than that, a glossary appended to the Mémoires of the Marquis de Feuquière, in 1735, explains "*Bagonet*, a short broad dagger, made with iron handles, and rings that go over the muzzle of the firelock."

The next and final improvement was the socket bayonet, and this time the French do not seem to have been the first to adopt it. Marshal Puységur says, "During the war of 1688, it had been proposed to the late king (Louis XIV.) to discontinue pikes and muskets; he even tested the effects of socket bayonets (*bayonettes à douille*) very similar to those in present use, on the muskets of his own regiment; but as the bayonets had not been fitted to the barrels, which were of different sizes, they were not very firm, so that in the trial which took place in the presence of his Majesty several of them fell off in firing, and in others the bullet in passing out broke the end, so that they were rejected. But a short while after, other countries, with whom we had been at war, laid aside their pikes, and took to fusils and socket-bayonets, to which we were obliged to return."‡

This passage is curious, not alone as describing the first days of the socket-bayonet, but also as showing that even in the king's regiment the arms were not of uniform pattern. The socket-bayonet was in general use in the French army in 1703-4.§ (Fig. 6.) Fig. 7 represents a curious Indian bayonet with locking ring, date 1810.||

We have doubtless often heard the bayonet called bagonet, which we have considered a vulgarism only to be ridiculed; it appears, however, to have been so designated by authority about the period of its introduction here. Mr. Akerman states that in a small MS. volume

* Mil. Ant. ed. 1812, vol. i, p. 155. (Liby. Roy. Un. Ser. Ins.)

† Vol. i 156.

‡ Art. de la Guerre, i, 148.

§ Ibid, i, 118.

|| In the possession of Capt. Tupper.

in his possession, written in the latter half of the 17th century, entitled "Exercise of Dragoons, composed for his Ma[ts] Roy[l] Regiment, by y[e] R[ht] Hon[ble] Louis, Earle of Feversham, Colonell." Among the instructions contained in it are:

"handle yo[r] baggonets.
"draw out yo[r] baggonets.
"mount your baggonetts altogether.
"fasten them into y[e] mussells of your musket."

They are further instructed to "march through a towne with musketts advanced, and through a quarter w[th] baggonetts in y[e] mussells of y[e] musketts."*

In February, 1686, the Coldstream Guards were supplied with bayonets for the first time. In the contingent disbursements made by the Regimental Quartermaster for that year is the following item:

"For taking out and carrying of the *Bagonets* for the regiment, &c."†

Even so late as 1735, the word was so printed. "*Bagonet* is a short broad dagger," &c., in the glossary before quoted.‡ The fact of the *baggonet* having been originally a simple *dagger*, may have had something to do with the corruption, and the practice of drill-instructors, as is well known, in all times has been to give that intonation to a word of command which is best heard at a distance.

There have been many modifications in the sockets of bayonets; specimens of many of them may be seen in the armoury of the Institution. At first the socket was only held to the barrel by a groove, which ran over the sight of the firelock (Plate xxxiv., Fig. 1); the consequence was, that upon bringing the muskets with the bayonets fixed from the "shoulder" to the "charge," it frequently happened that the bayonets were thrown off. Moreover, they were liable to be pulled off by the enemy. A remarkable instance of this occurred so lately as at the battle of Meeanee. I have it on the testimony of an officer of H.M.'s 22nd Regiment, who was present in the action. The Belooch swordsmen engaged the 22nd in fair hand-to-hand combat. So desperate were these men, that they tore off the bayonets from the firelocks. In consequence of this, at Hyderabad afterwards, the 22nd men, fore-warned by experience, lashed their bayonets on to the barrels with cord, or anything they could find.

The following anecdote of the above campaign on the same authority is worth repeating. A Belooch, sword in hand, rushed at one of the 22nd men standing on the bank of the Fulailee; the latter, with a thrust, received him on the point of his bayonet, which the Belooch seized with his hand, and with the bayonet in his possession rolled dead into the bed of the river. Upon seeing which, the soldier—an Irishman—cried out, "Give me back me baggonit, ye tief of the world!"

The first improvement in the socket, was the introduction of a short spring, screwed on the top of the socket, the screw of the spring serving for a sight when the bayonet was fixed; the spring holding

* Archæologia, xxxviii, p. 429.
† Mackinnon, app. 110 and 112.
‡ "Memoirs of the Marquis de Feuquière."

Fig. 1.

Fig. 2.

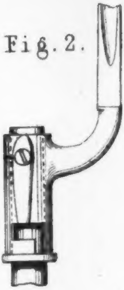


Fig. 3.

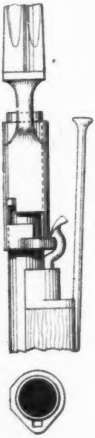


Fig. 6.

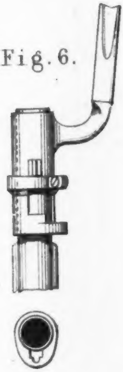
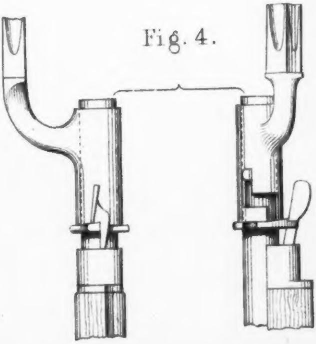


Fig. 4.



MODERN BAYONETS.

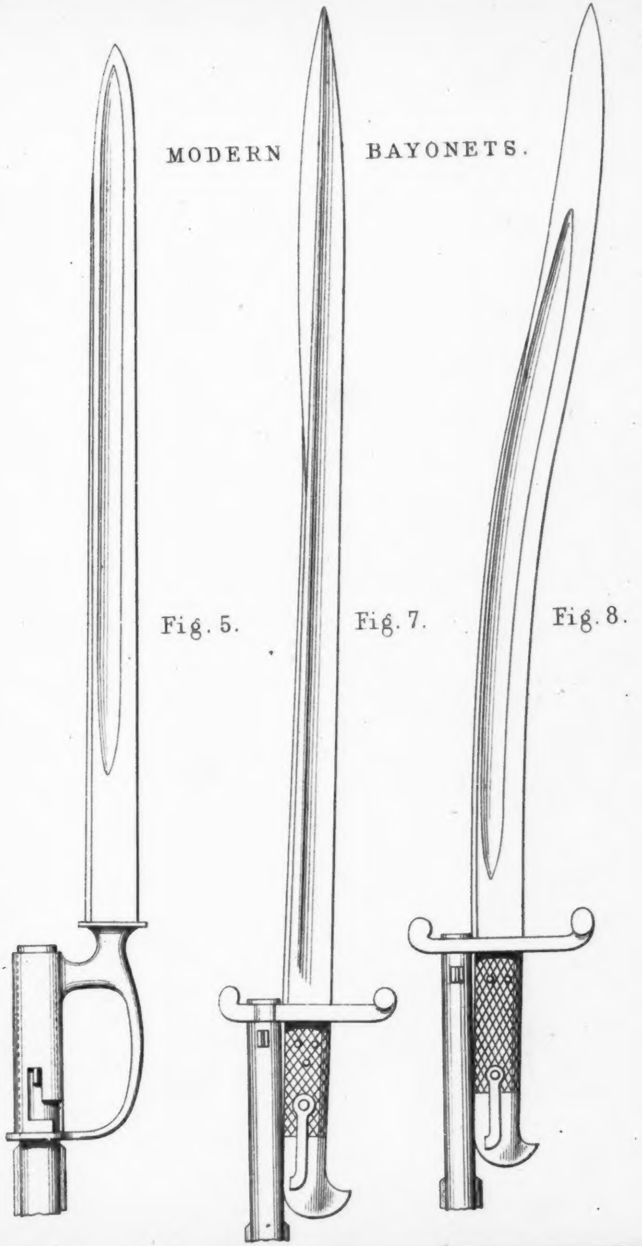


Fig. 5. Fig. 7. Fig. 8.

J.R.Jobbins.

on the sight of the barrel as a catch, which was therefore hidden by the socket. An example of this may be seen in the Government pattern. Land Regulars, Geo. IV., in Royl. Un. Ser. Mus. (Plate xxxiv, Fig. 2.)

The second was introduced in 1839. The motions were shorter, but in all cases they were guided by the sight. The spring was introduced underneath, and kept the bayonet from moving forward. The action of the spring is to press the bayonet on the barrel from the ramrod. Examples: Long sea-service and Light Companies. Tower, 1839 (Fig. 3).

The third may be seen in the line pattern, 1842. The spring is under the barrel, its action pressing to the lock-side of the barrel; as the sight is released from the first motion it pushes the socket into the second. The band of the bayonet is filed away, so that the first sight is always visible at the lower ranges. (Fig. 4).

In the pattern of 1853, the first motion is longer than the previous ones. No spring is used, but a locking-ring, which is turned to the lock-side, passes behind the front sight, and so fixes the bayonet. (Fig. 6.) Fig. 5 represents sappers sword bayonet, 1845, E. I. Service. Fig. 7 sword bayonet of Royal Engineers. Fig. 8, sword bayonet used with short Enfield.

The histories of modern campaigns abound with accounts of "splendid bayonet charges," but it has been seriously doubted whether *armies* have ever actually come into positive collision with that weapon. Bodies of infantry have, without doubt, been protected from being broken by cavalry by forming squares and fixing bayonets, and instances of individual attack and defence with the bayonet are numerous. Marshal Saxe, after describing the tactics of his day, and informing us in what manner battles were opened, suddenly inquires, "And what happens then? Why both sides begin to fire, which is a misery to behold. At length they advance upon each other, and generally at 50 or 60 paces, more or less, one or the other breaks and runs. Do you call that attacking?" *

In reply it may be said, that if that be the effect of the bayonet, it is the highest compliment that could be paid to it. Surely that weapon cannot be ineffective, the very sight of which scares an enemy! The late Colonel Mitchell, however, an accomplished writer on military subjects, altogether repudiated the idea of the bayonet as an effective weapon. In a series of papers on Tactics, which he contributed to the United Service Journal in 1831, he says, "The bayonet may in full truth be termed *the grand mystifier of modern tactics.* Let any one hold up at arm's length a musket and a bayonet, feel its weight and handiness, and look at its form; the entire of the *rickety zig-zag instrument* measuring from butt to point 6 feet 2 inches, projecting at the position of the charge about 3 feet 6 inches from the soldier's person, and weighing 12 lbs." "The British army," says he, in another place,† "during the Peninsular war encountered the best troops of continental Europe, those who at least had all but conquered

* "Mémoire de Comte de Saxe, p. 43. Liby. Roy. Un. Ser. Inst.)

† "Thoughts on Tactics," by Lt.-Col. Mitchell, p. 166.

Europe. The French infantry were always ready *pour faire le coup de fusil*, but who ever saw them await a bayonet charge?"

Mr. Guthrie, the eminent army surgeon, who accompanied the army from Roriça to Waterloo, is an excellent authority on the subject. "A great delusion," says he, "is cherished in Great Britain on the subject of the bayonet—a sort of monomania, very gratifying to the national vanity, but not quite in accordance with matter of fact. Opposing regiments, when formed in line, and charging with fixed bayonets, never meet, and struggle hand to hand and foot to foot, and this for the very best possible reason, that one side turns round and runs away as soon as the other side comes close enough to do mischief. Small parties of men may have personal conflicts after an affair has been decided; or in the subsequent scuffle, if they cannot get out of the way fast enough. The battle of Maida is usually referred to as a remarkable instance of a bayonet fight; nevertheless, the sufferers, whether killed or wounded, French or English, suffered from bullets, not bayonets. Wounds from bayonets were not less rare in the Peninsular war. It may be, that all those who were bayoneted were killed, yet their bodies were seldom found."

The list of killed and wounded by bayonets may be small, but no one will question the moral effect produced by a bayonet charge, and I firmly believe that instances are rare of British infantry "not waiting" for it.

At Fuentes de Onoro, in May, 1811, the 88th cleared the streets, and bayoneted down the French Grenadiers. At Barossa the French advanced in their usual gallant manner of impetuous attack, which few nations have been able to withstand. The gallant Graham, although left alone in the plain, with his feeble, starving band,* and scarcely having time to form, instantly defied the French divisions. The English line quietly waited for the attack, and then riddled the head of the column with a deadly fire, then charged with the bayonet, and one hour and a-half settled the affair. General Graham (afterwards Lord Lyndoch) thought it necessary to apologise for the rashness of attacking with his handful two entire French divisions. The Duke, however, replied, "I congratulate you and the brave troops under your command, on the signal victory which you gained on the 5th instant."† Lord Hill at Almaraz (from whence one of his titles was derived), with the 1st battalion 50th, and one wing of the 71st, attacked Fort Napoleon, defended by 9 guns, and between 400 and 500 French troops. The works were escaladed in three places, and the garrison was driven at the point of the bayonet through the several intrenchments, and many leapt down into the river from sheer panic.‡

We may presume that this was what the Duke of Wellington called "bludgeon work."§ Again, "Two British regiments (27th and 48th) fell upon the enemy three separate times with the bayonet, and

* "The British having been twenty-four hours under arms, without food, were too exhausted to pursue." Napier, Pen. War, iii, 445.

† Despatches, vii, 395.

‡ Ibid, ix, pp. 169, 185.

§ Napier, Pen. War, vi, 140.

lost more than half their own numbers."* This was at the first battle of Sauroren. Soult took credit for having nearly destroyed the 20th regiment at the heights of Pampeluna, when only three companies were engaged. "Leurs pertes," he reports, "ont également été considérables, soit à l'attaque du Lindorez par le génl. Reille où le 20me régiment a été presque détruie à la suite d'une charge à la bayonette exécutée par un bataillon du 6me leger, soit à l'attaque d'Altobiscar."† M. General Cole reports, "The enemy were perceived moving in very considerable force along the ridge leading to the Puerto de Mendichurri. M. General Ross attacked him with the Brunswick company and *three companies* of the 20th, all he had time to form; these actually closed with the enemy, and bayoneted several in the ranks. They were, however, forced to yield to superior numbers."‡ In Cannon's records the affair is thus reported: "The left wing (20th) and a regiment of Brunswickers ascended to the summit, the light company and Brunswickers taking post in front in skirmishing order. The skirmishers were driven in by a very superior force of the enemy" (p. 43). The casualties in the 20th amounted to 3 officers killed and 6 wounded (a large proportion of officers), 2 sergeants, 2 corporals, and 10 men killed, 105 wounded, and 12 missing.

Having unfortunately no practical experience of my own on this subject, I referred to those whose services entitled them to be considered authorities, and I beg here to acknowledge the kindness of the communications which I received. General Sir De Lacy Evans writes, "I certainly have not known any instances of armies crossing bayonets. I believe that one of the parties invariably *turns tail.* But the bayonet is one of the most important of all our weapons; it combines the ancient pike or lance with the modern musket or rifle. It increases the confidence of the soldier, and intimidates his opponent, and of all the soldiers of Europe, the British soldier is the last to resort to the turn-tail practice, and never, unless under the impression of being extremely out-numbered."

The Chaplain-General favoured me with the following:—"Mr. Guthrie is perfectly right. Except in night affairs, in the assault of towns, and when troops come suddenly and unexpectedly together, I do not believe that the bayonets of infantry ever cross. In my own experience, I know of only three such close encounters.

One occurred during the succession of actions, which are called by the common title of the battles of the Pyrenees; when Captain George Tovey, at the head of the Grenadier company of the 20th regiment, actually charged the head of a French column, and drove it back. He came upon the enemy at once, by rounding the corner of a rock, and his men did stab the leading files. The column melted away from the rear, though it probably numbered 3 or 4,000 men.

The second was in the assault of San Sebastian, when the French stood on the top of the breach, till several of them fell on the bayonets of our men.

* Napier, Pen. War, vi, 139.

† Soult to the Minister of War. Napier, App. vol. vi.

‡ General Cole to Lord Wellington.

The third was before New Orleans, on the night of the 23rd December, 1814; when a body of men belonging to the 85th and the Rifle Brigade, charged the flanks of an American battalion, and drove it off the ground. I had then a bayonet in my own throat, of which I still carry the mark; I cut down the man, whose firelock I had seized with my left hand. The number of combatants on our side in this affair did not exceed 40; the enemy, taken by surprise, might be 400."

A gallant old soldier, one of the Vice-Presidents of this Institution, writes—"I have seen many battle-fields, here and there, and observed that one or two files had come into contact with the bayonet; but that even two battalions have ever come into collision, I do not believe."*

Jomini testifies to the same effect:—"Ce n'est guère que dans les villages, dans les défilés, que jai vu de mêlées réelles d'infanterie en colonnes, dont les têtes se choquaient, à la bayonnette; en position de bataille je n'ai jamais rien vu de semblable."†

Our great battles on land have been infantry battles. Crécy, Poitiers, and Agincourt were won by the superiority of our infantry. Why was our infantry superior? Because, in those days at least, the foot-soldier was better treated, socially speaking, in England than elsewhere; he was better paid, and consequently better fed. The service being remunerative, brought forward a superior class of men—that class which is the pride of our country—the yeomen. Archery was their pastime, and butts were set up in every parish, as we may hope to see them again. It was the free constitution under which they lived, that made them what they were, and what we are. No slaves would have resisted as those men did.

The bayonet, although not invented here, is recognised as a British weapon for the same reason that the long bow was considered the English one, *par excellence*, because it required a strong arm to render it effective. In a bull-dog struggle for life or death, blood, bone, and bottom must tell. A purely physical superiority generates from consciousness of its power, a moral confidence. Long may we have reason to enjoy that confidence, so long as we use our power in a righteous cause, for defence, not aggression; without vain boasting, and in firm reliance on that Providence, which has hitherto so wonderfully protected us.

"Ergo qui desiderat pacem, præparet bellum. Qui victoriam cupit, milites imbuat diligenter. Qui secundos optat eventus, dimicet arte, non casu. Nemo provocare, nemo audet offendere,"—"Vegetius de Re Mil." lib. iii, prolog.

"The English Infantry," wrote General Foy, a bitter detractor from the merit of the sons of Albion, "is not afraid of charging the enemy with the bayonet."‡

* Major Loraine White, late 81st Regiment.

† Précis de l'Art de la Guerre, p. 570. (Library Roy. United Service Inst.)

‡ "History of the Peninsular War," i, 197. (Library Roy. United Service Inst.)

An important cause of the success of the bayonet in the hands of British troops may be found in the fact of their attacking in extended order instead of the column formation. On this point Sir W. Napier expresses himself—"The rapidity with which the French soldiers rallied and recovered their order after a severe check was admirable, but their habitual method of attacking in column cannot be praised. Against the Austrians, Russians, and Prussians it may sometimes be successful, bnt against the British it must always fail, because the English infantry is sufficiently firm, intelligent, and well disciplined to wait calmly in line for the adverse masses, and sufficiently bold to close upon them with the bayonet."*

That the bayonet continues still in active operation, we may learn from General Forey's dispatch on the capture of Puebla:—"For the first time," writes he, "the Mexicans felt the points of our bayonets. They gave way before the impetuosity of our attack."

The necessity of increasing the efficiency of the soldier by introducing a system of athletic exercises has been forced upon the attention of military administrations. In some of the leading armies of the Continent, the promotion of gymnastics is encouraged by the strongest inducements. The practice of the bayonet in attack and defence presents a ready means of developing the qualities of the soldier. The American General, M'Clellan, has published a manual (a modified translation from the French of M. Gomard), whose system, after an examination of those of Selmnitz, Pinette, Müller, &c., appeared to him eminently superior. Gomard lays it down as a principle, that the most formidable antagonist an infantry soldier can encounter is an infantry soldier; that the bayonet is more formidable than either the lance or the sabre. "This assertion," says General M'Clellan, "may seem surprising, but trial will convince any one of its truth, and of the consequent fact that an infantry soldier, who can parry the attacks of a well-drilled infantry soldier, has nothing to fear from a cavalry soldier, because simple variations of the parries against infantry are perfectly effective against the sabre and lance; *e.g.*, the parries in high tierce and high quarte. . . . . It will be proper to remark," he continues, "that any system of fencing with the bayonet can, in service, have its full and direct application only when the men are isolated or in very open order. In the habitual formation, as infantry of the line, the small interval allowed each file, and the method of action of masses, will prevent the possibility or necessity of the employment of much individual address; but even then, in the shock of a charge, or when awaiting the attack of cavalry, the men will surely be more steady and composed, from the consciousness of the fact that they can make good use of their bayonets, and easily protect their persons against everything but balls."

One is glad to learn that public attention is drawn to this matter at home, and that the exercise is now adopted throughout the infantry of the British army. A spring practice bayonet, to enable "loose play," or fencing, to be carried on with the bayonet in the same manner that the

* "History Peninsular War," i. 265.

foil or single-stick is used to represent the rapier or sabre, has been in constant use in the 3rd battalion Grenadier Guards for nearly two years, without the slightest accident. Similar ones are also employed at Messrs. Angelo's, and some of the other schools of arms in London. The bayonet slides freely down a grove at the side of the barrel, so as to recede when it touches the adversary in a thrust. It is fitted with a small india-rubber spring, which returns it to its place immediately the pressure is removed. It is the same weight and length as the regulation Enfield rifle.* It can scarcely be necessary for me to mention here that the bayonet and rifle are now made entirely by machinery at the Royal Small Arms Factory, Enfield. Specimens illustrative of the formation of the bayonet in all its stages (and there are 49), from the rough piece of metal to the polished weapon, are to be seen in the Museum of this Institution.

I stated at the outset that it was not my intention to speculate upon the future of the bayonet. Of course it requires no great amount of prescience to pronounce that in the increased power of projectiles, and the rifling of all *bouches-à-feu*, the attack will be made at much longer range, and the destruction of life will be much more rapid, so that whether the bayonet will be called into play to decide the fate of wavering battalions, is difficult to anticipate. If, however, in the course of events, this kingdom shall again be plunged into war, we may hope confidently that the stout heart and strong arm may still be ours, and that they to whom the safety and honour of our common country shall be entrusted, will be found to be, as they hitherto have been, no degenerate scions of those brave men who fought and conquered, and gained imperishable glory, on the ancient battle-fields of Crecy, Poitiers and Agincourt.

* I am indebted to Mr. Latham, the inventor of the spring practice bayonet for this information, and for producing a specimen at the lecture. He tells me that he has supplied eight of them to the War Department, and that they have been very favourably reported upon.

LECTURE.

Friday, May 29, 1863.

Colonel P. J. Yorke, F.R.S., in the Chair.

NAVAL AND MILITARY SIGNALS.

By Lieutenant P. H. Colomb, R.N

Part I.

Signals in General and Day-signals.

The subject to which I have the honour to invite your attention this afternoon, is one which—although of the greatest importance—but little pains have been taken to systematize, or to place on such general grounds as may show in what manner the practical questions involved may be best treated. It is quite true that very great attention has been constantly bestowed upon the subject by officers in both the services, as well as by persons unconnected with either; but this attention, so far from clearing the view of the subject, has generally produced a contrary effect.

Those who have given most time and attention to the matter, have usually commenced their study by fixing on some scheme for remedying the real or supposed defects of existing systems of signals; and, having at the commencement settled the question to their own satisfaction, they become, to a certain extent, partial judges of the points arising from their after knowledge. In this manner the question has only received what I might call a piecemeal treatment; an enlarged view has not been taken of it, and the utmost vagueness and uncertainty characterizes our opinions regarding it—a state of things which, indeed, is not to be wondered at, seeing the immense number

of considerations necessary to be taken into account in its treatment. And yet it is a subject of at least sufficient importance to challenge fairer usage. To the naval service, at any rate, there are few of greater moment, whilst the military authorities are becoming more and more alive to the vast increase in the efficiency of our forces which may be gained by the employment of military signals.

It will be my endeavour in this, and in the lecture I shall have the honour of delivering on Monday night, to take something like a comprehensive view of the subject—to open up, as far as may be done in the time allotted to me, the leading points which govern it, the principles on which signalling depends, and the manner in which those principles have been applied in the different systems which have been from time to time proposed for the naval and military services. I cannot pretend that I shall be able to place before you anything like an exhaustative picture of the subject. I can, after all, but put forward a slight and unfinished outline; and I must hope for your kind indulgence towards the many unfilled gaps which will, I fear, be left after the conclusion of my lectures.

More than two thousand years ago, a Greek historian urged upon the authorities the value and importance of military signals. Polybius devoted a chapter of his History to the consideration of the subject, and was himself the inventor of a complete system, which will well bear comparison with many of recent birth.

At that time, naval signals were of the simplest possible character, and consisted either of a red flag or a brazen shield, which was hung out from the admiral's galley, and by its motion from left to right, backwards or forwards, regulated the change of course, the advance or retreat of the squadrons.

That signalling should thus have been in a more forward state in the land service at this time than in the navy, is explained by the ease with which orders could be conveyed by word of mouth at sea. Whilst the vessels were small, and propelled by oars, so that a whole fleet occupied but a very small area when formed for action, or sailing in order, the verbal message was efficient; whilst in the land service, the accidents of the ground often stepped in the way of verbal communication. Thus, we find that in Richard the First's fleet, the ships of each line were close enough together to permit of speech between them, whilst the lines themselves were within trumpet-call.

As the ships increased in tonnage, and became comparatively unwieldy, by the discontinuance of oar-propulsion, the importance of some mode of conveying the admiral's orders, other than the verbal message, manifested itself; and accordingly we find, that about James the Second's time, a system of signalling by means of coloured flags was coming into use. I say a "system," but in reality it did not grow into one for a hundred years after this period.

There were thirteen flags, of various colours, and they were disposed about the ship in every variety of position, without the smallest attempt at order, and 102 signals only could be displayed by this means. The signal-book of about 1710 is very curious. Each signal requires the representation of a whole ship to display its character;

and in some cases, the position of the sails appears to alter the character of the signal.

As far as I know, this system served the purposes of the navy until about 1780, when the unfortunate Kempenfelt made many improvements in it. There is a M.S. copy of this officer's signal-book in the library of this Institution, which, as a record, is extremely valuable. The flags in this book are not numbered. There are twenty-seven in all, counting pendants, and they are used singly or in pairs only, to denote the different orders.

According to Brenton, when Lord Howe fought the battle of the First of June, his flag-ships only had the means of making 183 signals, whilst a private ship could only make 68. Four years later, or 1799, found flag-ships with their power of signalling increased to 310 signals, and private ships to 80. Some idea of the difference which sixty-four years have produced, may be given when it is stated that every ship in the navy can now display, by the signal-books, nearly 14,000 distinct signals, whilst the Commercial Code provides for at least 78,000!

Sir Home Popham published improved signal-books in 1801 and 1812, and gave thus the basis on which our "Vocabulary" signals are founded, whilst the traces of the older plans remain embodied in our "General Signal-Book."

But though naval signals have thus gone on progressing in extent and usefulness, military signals, until within the last two or three years, had grievously fallen from the high estate they occupied in the Greek historian's mind. In fact signalling, as a portion of military science, has been in complete abeyance until nearly the present time. The reason why this has been the case is simply because, whilst the conveyance of an order by word of mouth in the navy has been growing every day more difficult, in the land service if it has not become easier, it has at least remained nearly stationary. So that the want of a signal system, if it pressed at all, did not press to the production of a system until the year 1861. In that year I assisted in arranging a signal-book and an apparatus for military purposes under the direction of the Ordnance Select Committee. This system and apparatus must, however, be considered as only provisionally introduced; for although the arrangement was perhaps the best which could then be devised, with the amount of knowledge possessed by the compilers, two years' study and experiment have convinced me that the system is capable of great improvement, and that much requires to be done before military wants can be satisfied.

The importance of the question of "Naval and Military Signals" may be viewed from several different aspects.

First, it may be looked at solely from the naval point of view; as to how the efficiency of our fleets would suffer if deprived of their signal-books and flags; and how it *does* suffer at the present moment in the case of our night signals, where the existing system fails to do its duty. These points I need not enlarge on here, for every naval officer is perfectly aware of the utter impossibility of carrying out the service without signals, and also because I shall bring

the failure of existing systems more clearly before you at my next lecture.

It may next be looked at from the purely military point of view. As to how military movements may be facilitated and organization assisted by the adoption of a comprehensive system of signals. The consideration of this part of the subject naturally divides itself into two heads—namely, evolutionary signals, or signals to be used in the field with troops in motion; and signals between fixed positions, as works, camps, &c. To provide for the former object, as it is by far the most important, so it is by far the most difficult of the two. It is the most important, because you already have the electric telegraph, which will in nine cases out of ten do the work between fixed positions better than any system of that which is usually termed "signalling." Again, because it is in time of war and in the actual presence of the enemy, that the most momentous results flow from the despatch of orders or intelligence. During peace in the military service, orders transmitted by signal, as they are deprived of the urgency of war messages, so are they, if mistaken, liable only to produce temporary derangement or inconvenience.

It would hardly become me, as a naval officer, to speak of the possibility or impossibility of facilitating the handling of an army by means of signals, but I believe I am not mistaken in supposing that such a development of the principle is not shut out from the view of many military men.

I remember, in passing over the scene of that terrible cavalry charge at Balaklava, in the year 1856, being struck by the thought that a system of military signals in common use, might have saved the lives so unfortunately sacrificed. The Commander-in-Chief was, I believe, in full view of the troops, and might have directed them entirely by means of visual signals, instead of trusting to the hasty message, and the loss of time consequent on the messenger having to traverse so much ground, with the chances also of accident on his way.

The question also may be viewed specially in connection with the defence of our coasts. Should the great calamity of a war with our continental neighbour ever fall upon us, it would be almost at once found that some means of communication between the shore and ships, of much more extended powers than any yet used would be required. Steam, in the increased speed and certainty of movement it has bestowed on fleets, has brought before us the necessity of beating them by the speedy conveyance of intelligence.

The policy of France, in an English war, would be again what it ever has been, to watch its opportunity when our fleets were scattered, and, by a rapid combination, to make a dash at our most vulnerable point. And this would now take place in small expeditions as well as large ones. As the sailing and arrival at its destination of such an expedition would be now a matter of a few hours only, the utmost vigilance would be necessary to give the selected point of attack sufficient warning to prevent surprise.

Suppose a look-out vessel heralding the approach of a small but

fast-steaming squadron from Cherbourg, to make a dash at a rich convoy, under the shelter of Plymouth Breakwater,—say she is only an hour or two ahead of the enemy,—must she wait until she can come close into the Sound before she can communicate her desperately important intelligence? Or, ought she not to have the means of despatching her news almost on sighting the English coast?

Then again, suppose our main fleet to be off the Lizard, on a false scent purposely laid for it, say the fleet is fifteen or twenty miles off; certain intelligence reaches the government of the true destination of a hostile squadron, how is the fleet to be reached, and the necessary orders conveyed to it? Ought it not to be done viâ the Lizard and by signal?

Though these wants are quite capable of fulfilment, no means whatever exist for doing so at the present moment. Once out of sight of the ships in Plymouth Sound, or at Spithead, and, as far as intelligence is concerned, a ship might also be out of sight of land; except, indeed, that there are means of communicating commercial intelligence to Lloyds by signal, viâ Hurst Castle and Deal.

Lastly, the naval and military signal question may be looked at in its naval and military sense, that is, as a means of intercommunication between the two services under all circumstances. The "Army Signal-Book," and the arrangements contained in it, will, I hope, be found very useful in future for this purpose. But the state of affairs is not quite satisfactory after all, for we have the army using for its own purposes a system not in general use in the navy, and the navy doing the same with regard to the army; so that, in their intercommunication, each service would find itself harassed with comparatively unknown methods of signalling. However, that there should be *any* plans existing, whereby joint communications can be arranged, must be considered a great step towards efficiency.

One point should be mentioned here, which the military authorities may well bear in mind. Should the army strike out its own course in the matter of signals, it must not be surprised that the navy does not follow the lead. The question of signals for the navy cannot suffer much modification for any purposes but its own, whilst it is doubtful if in the army the subject will ever assume such vital importance as to prevent its alteration to suit the exigencies of the navy. My own opinion is, that the wants of both services are very nearly identical, and that the army, in breaking this new ground, may fearlessly follow the well-trodden path of naval signals.

Having now touched slightly on the principal uses to which signalling may be put in the naval and military services, let us consider the principles on which signalling depends, so that we may draw clear conclusions as to how all the wants touched on may be fulfilled.

I suppose that the inventors who have tried their hands at some one or more branches of naval and military signals, may be numbered by dozens. I am myself acquainted with certainly twenty signal inventors, and the systems I have made it my business to investigate are in very large numbers. In fact, I believe that most naval officers have, at one time or another, produced signal systems; some few

have been thoroughly carried out, but by far the greater part never got beyond the embryo state. Iu these lectures I can but glance at these different systems; but I hope, at some future time, to do so in a more complete manner.

We may, perhaps, best form correct ideas on the subject by going to the very beginning of it, and asking the simple question, "What is a signal?" The answer is, that it is any means of conveying thought. What are speech and writing but signalling? They are means of conveying thoughts by certain previously-arranged symbols, or sounds; and signalling proper is but a mode of doing this to distances greater than those attainable by the ordinary modes of speech or action; and, according to the certainty and rapidity with which thoughts can be conveyed, so is the efficiency of the system used, to be judged.

The next point to be considered is, what means are at our disposal for performing the operation of conveying messages or "thought" to these greater distances? Of what elements must the necessary symbols be composed?

Signals, then, may be transmitted by means of *form*, *colour*, *sound*, and *motion;* and into these elements, either singly or collectively, all systems of signals, either day or night, may be resolved.

In most existing systems of signals, two or more of these elements are involved; but still there are a few which depend upon a single one.

By far the greater part of those hitherto produced have depended on *form* and *colour* for the formation of their signs; and those systems are the best in which least colour is involved.

No existing system of day-signals depends exclusively on *colour*, although some employ it much more than is either necessary or judicious. There are, however, some systems of night-signals which employ colour alone.

There are several systems both of day and night signals which depend on *form* only.

No existing system depends solely on sound, if we exclude the bugle-calls; although sound is used as an auxiliary by some systems, and as a means in others, of expressing signs, otherwise composed of visible objects.

The last element—and, in my mind, by no means the least important—is motion, which, until quite recently, has been altogether overlooked as a means of signalling, except in the arrangements of the electric telegraph, where it has always been largely used. Of course, a certain amount of motion is required in all systems of signals, as the essence of signalling is change, and change cannot be produced without motion; but the kind of change which constitutes a signal by motion is above and beyond the ordinary amount.

Let me, even at the risk of wearying you with my minuteness, explain, in the simplest manner, the action of the different elements touched on in reference to signalling.

Suppose that a signal, which is represented by the figure 3, has to be conveyed. To display it, simply painted on a card, thus— $\boxed{3}$

would be, of course, the simplest and most natural mode of doing it; and this would constitute a signal by *form* only. Any other pre-arranged, uncoloured shape, such as this , or three balls,  or three lights,  would still convey the signal by means of *form* only.

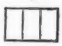
The signal would be conveyed by means of *colour* only, were all the signs in the system the same shape, but differently coloured, thus— 

, 

. It would still be a colour system only if—the shapes being still identical—each of them was coloured with two or more tints, and the tints were disposed, as to their light and dark shades, in the same manner, thus— 

, 

.

If, however, the colours were variously placed as to their light and dark shades, on the still identical shapes, the system would cease to depend entirely on colour, and would use form also, thus— , 

Sound, as a means of signalling, may either be used as a monotone, or different tones may be used in combination with time, or, what is the same thing, *motion.*

Suppose, now, that, instead of either displaying a body of a certain shape or a certain colour, to represent the figure 3, any object, such as the arm, be raised three times to a certain position, at equal intervals of time, that would constitute a signal by *motion;* and, if but one object be used, and there be only two positions in which it can be placed, such a system would be exclusively dependent on *motion.*

Such, then, are the different means, described in very plain language, out of which the signs must be constructed which are to represent the necessary figures, letters, words, or sentences, in any system of signals.

Now, we cannot choose which of these four bases will be most advantageous for our signal system until we have carefully reflected upon the work that system has to perform. The first question to be answered is, will the system be required to address several points simultaneously, or only one? The second, what number of acknowledgments or answers, in proportion to the signs transmitted, will, in practice, be required from the receiver of them?

Omitting, for the present, the discussion of a point which many authorities consider is at least debateable—the advisability of using a code of signals in preference to spelling—let us suppose it settled that a code of some kind is to be used.

Such a code will consist of a long list under some alphabetical arrangement, of the words, expressions, or orders likely to be used in naval and military operations. Generally speaking, the number of such sentences and words wil! not exceed 15,000; and, in order to fulfil the primary object of a code—the conveyance of the greatest amount of meaning by the smallest number of signs—arrangements will probably be made that each word or sentence may be expressed by not more than 4 or 5 signs.

The code being thus arranged, the question arises next—is it necessary that you should be able to address by signal several points simultaneously? or will you never be called on to address more than one point at a time?

For naval purposes, it is unnecessary to do more than point out that the whole scheme of our signals rests on the necessity which exists for conveying signals in all directions at the same time. It is a *sine quâ non* of our arrangements; and considerable sacrifices are made to carry it out.

Subject, of course, to correction from military men, I believe that, for the purposes of the army, this power is every whit as necessary. An organised fleet is composed of squadrons, sub-squadrons, and single ships; an organised army, of divisions, brigades, and regiments. The admiral in command of a fleet conveys his orders by signal to the whole fleet, to any squadron, sub-squadron, or single ship. If signals are to be effective in the army, it will surely be necessary to convey orders by them to the whole army, to any division, brigade, or regiment. Again, in camp, or even in garrison, there is generally some point sufficiently elevated to be seen from the different posts or head-quarters. We may suppose that, as signalling becomes common, these elevations will be made use of as signal stations, whence the orders of the officers in command may be promulgated by signal. It will be apparent that at least the *power* of addressing all these different points simultaneously must be provided.

Suppose, for instance, that in a garrison town such as Plymouth, with the regiments scattered in different barracks, one or two miles apart, but all of them in sight of an eminence close to the General's quarters, where the signalling apparatus is established. Suppose that this apparatus is only calculated for the transmission of signals in one direction, and that it be required to order the assembly at the Brigade-office of all the commanding officers immediately. The signal representing this order is displayed, say to station No. 1. But the attention of the signalman of No. 1 does not happen at that moment to be fixed on the head-quarter station, and there is, consequently, delay. At last the signal is answered, but in the meantime all the other stations have been in complete ignorance of what was taking place. So the signal passes round to every station, and when it arrives at the last, how much valuable time has been lost? It must be quite apparent, in short, that unless the army be provided with the means of addressing by signal more than one point at a time, we need not expect to see signals either largely used, or very effective.

Now comes the question.—What is required of any system of

signals in order to insure its addressing many points at a time with facility?

It will probably be asserted that nothing more is required than to make whatever symbols are used, present the same appearance in every direction. This, however, is but a small part of what is necessary. Another and very important quality is requisite, which depends upon the number of answers or acknowledgments which are called for, in order to insure the certainty of the signal communication.

Now as a *rule*, it may be said that every *change* requires acknowledgment from each station. This is the rule we must lay down, in order to understand the subject; it is very often broken through in exceptional cases, and never paid the slightest attention to in the electric telegraph systems, and in others which I shall bring before you. But still it is the rule on which nearly all existing visual systems proceed, and for the present we must accept it.

Now as every change must be answered, the object aimed at is, to have as few changes as possible, and thus to let each answer cover as much meaning as can be arranged for. This object is gained by gathering the proper symbols into groups, and so displaying them that the whole of each group is seen at one view.

This principle of gathering into groups is found in all systems of flag signals by daylight, and is attempted, but not carried out, in the royal, as well as in most other established systems of naval night-signals. It is more important to be attended to when addressing many points, than when only addressing *one*, and its use even diminishes the rapidity of communication with a single point, yet, as before said, it holds its ground in most existing systems, and I believe will continue to hold it.

If the symbols be not gathered into groups, they are transmitted one by one, and answered as transmitted.

We have here, then, two great principles, between which we have to choose, either of which is found in all systems of signals, and each of which, as we shall see, has its own special advantages and disadvantages, and we are called on to decide which we can adopt with most regard to the efficiency of naval and military signals.

I call the systems founded on these principles "general" and "telegraphic" systems respectively.

The general system, then, gathers into and displays its symbols in groups. In order to decrease the size of its groups, it generally increases the number of its symbols, and in all cases it contemplates addressing many points simultaneously.

The telegraphic system, on the contrary, does not group its symbols. As it does not group them, it is in no way bound as to the number of symbols employed, and it therefore uses the fewest possible. It never contemplates addressing more than one point at a time.

Examples of general systems are found in all flag systems, in Colonel Grant's figures, and in my Multiform Telegraph, which I shall hereafter describe.

Examples of the telegraphic system are found in Redl's Cone Telegraph and the systems deduced from it, the Semaphore, and most of the recent systems of night-signals proposed.

There are some systems which are capable of use, either as general or telegraphic systems, and which really retain the good points of both.

The telegraphic system has two advantages not possessed by the general system, which must be noticed in passing. In the first place, as a rule, the changes from symbol to symbol can be made with rapidity so great, that when addressing a single point, its superiority to the general system is very remarkable.

Flag signals, for instance, do not attain, in making a long message, to one station, a greater speed than three figures per minute, when the group consists of three symbols. The semaphore, under the same circumstances, sends 7 figures per minute, and Redl's cone telegraph about 10 figures per minute, though it is quite capable of sending 24 figures per minute at short ranges.

Again, as the system displays but one symbol at a time, each symbol can be so much larger than those used by the general system, as in one case three or perhaps four symbols are displayed, where only one is in the other. Each symbol being so much larger, is therefore so much more visible, and the distance at which it is available is so much greater.

But the general system has other advantages, which in their turn are not shared by the telegraphic system.

We have hitherto supposed that if any four figures require transmission to a certain point by a telegraphic system, four answers are required, and no more.. This, however, is in no case the fact. As the telegraph system uses so few symbols, it must, before displaying them as a signal, declare to what they refer, whether to the code, to figures, letters, or particular tables. Consequently, before a telegraphic signal is made, at least *one* preparatory signal takes place, which must be answered, and which expresses nothing more than "I am about to make you a signal, and the symbols to follow refer to such and such a code or chapter." Then again after the series of symbols has been transmitted, there is a necessity for what is called a "stop;" this is a sign which signifies the termination of a group, word, or sentence, and this also requires acknowledgement before either the signal is terminated, or other parts of it can be proceeded with. Thus if the code is arranged so that four figures represent a certain order, and a telegraphic system is used with it, the order cannot be conveyed without requiring *six* acknowledgments at the least from the station addressed. Whilst a general system under the same circumstances would only require *one*.

Now, when using a telegraphic system to a single station, these changes and acknowledgments can be made so rapidly as to occupy in a long message, as I before said, a less time than the smaller number of answers called for by the general system, because the change from group to group cannot be made with anything like the rapidity with which the single figures follow one another. But when a number of stations are addressed, the case is completely reversed. The delays in collecting answers, which are hardly noticeable with a single station, become altogether too great for efficiency when multiplied; whilst with the general system the time lost in preparing each

group for display is very much more than compensated by the gain of time in the collection of the smaller number of answers.

An appropriate, although homely illustration of this, may be taken from the dealing of a pack of cards. If the dealer has ten persons to supply with four cards each, he will find it a much more expeditious mode of proceeding to deal four cards to each person at once, than to go with single cards four times round the circle. And this is exactly what takes place in transmitting four symbols to a number of points by signal. It is very much more speedy to transmit them in a group than singly.

But a very important consideration with regard to the *certainty* of our signalling comes at this point to assist in supporting the general system. Suppose we are using a code such as Wilmot's Boats' Signals in actual service, and it is necessary to warn an outpost that "the enemy is advancing on it with guns," the sentence is represented in the code by the figures 480. If we are using a telegraphic system, we must first make a preparatory signal, and when this is seen by the station in question, it only conveys the information that a signal is about to follow from the Boats' Signal-book. The preparative is answered, and then each figure of the three separately, and then the "stop" to show that the signal consists of three figures only. Now it is evident that the station addressed, though obliged to acknowledge each figure as displayed, cannot refer to the code for verification until the "stop" appears, and it is only *then*, by looking at the purport of the figures received, as set down in the code opposite them, that any meaning whatever can be drawn from the signalling. Suppose now that the figure 5 has been mistaken for, or in the hurry set down as the figure 4. The signal, as received, would mean "destroy or set fire to the gun-carriages." If the officer in command of the outpost is not satisfied with this interpretation, he will request a repetition of the signal before obeying the order. But if it does not seem an unlikely order, he will obey it, and thus a dangerous error has taken place. Now, were the same signal sent by a general system as the three figures are all displayed together, there is ample opportunity of carefully comparing the symbols shown with their purport in the code, and if there is the slightest shadow of doubt as to the appearance of any of them being mistaken, careful reference *there* will assist in solving it, and that, too, before any acknowledgment whatever is made. In short, the receiver of a general signal acknowledges only the purport of the signal, whilst with a telegraphic system he must acknowledge the receipt of signs which have no present meaning. There is the check of context therefore on the errors of vision in the one case, whilst there is no check in the other.

From these considerations it may be stated, that all other things being equal, the amount of probable error in a system varies as the number of answers required.

The question of the effect of *practice*, in signalling, or the want of it, is one which ought to weigh very heavily in the selection of a system of naval and military signals. It is one which is very well understood in the navy, where we are constantly brought into contact with it;

but the army being only on the borders of the question, has not yet met it in much force.

I may state at once, with the certainty of general acquiescence, that the amount of practice in signalling in the army will not be greater than that already gained in the navy.

The naval signalman, as he at present exists, may be taken as a fair sample of the military signalman as he *will* exist. Now, in my five years' study of this subject, it has fallen to my lot to instruct very large numbers of signalmen in different systems of signals, and to watch the effect of a cessation of instruction and practice upon them. The instances have been very rare in which I have found a signalman capable of efficiently working two distinct systems of signals. Signalmen in the habit of working the semaphore have complained much of the difficulty they have found in working it and Redl's cone telegraph alternately; and when once in the habit of using the cone telegraph, a return to the semaphore has been found very difficult.

In like manner I have noticed that even in the very simplest systems of signals, a few weeks' cessation from all, has rendered a signalman almost oblivious of the whole arrangements.

One of the causes of the constant failure of our naval night-signals is unfamiliarity with the system, which again proceeds from want of practice.

I have previously shown that signals by flags are slow in comparison with other existing systems. To a single point, they are, beyond all comparison, the slowest produced. One would suppose, that this being so, any system proposing to remedy such a defect, as an auxiliary, so to speak, would meet with instant support and encouragement. There is the ship semaphore ready, as well as Redl's cones, to do the work, and yet both, although very simple and easily learnt, have dropped out of use.

Again, it is well known that our ordinary flag signals, in certain rare cases, such as calms and distance, fail to do their work. Many plans have been from time to time proposed as remedies, and some of them undoubtedly answer well. Our distant signals especially are, according to my experiments, very efficient; but how few of our naval officers have seen them in actual practice? This is not at all because occasions for them do not arise, but simply because, from their rareness, practice in the use of them is not sufficiently great to cause us to turn naturally to them when other methods fail.

If we wanted more evidence on this point, we might turn to the first pages of Wilmot's Signal-book, wherein are laid down twelve distinct modes of making signals, or to Reynold's Code, which gives seven, or to Richardson's, which gives three. Here are then twenty-one different systems of signals, all of them efficient, under their proper circumstances, all clearly laid down, and requiring comparatively little study; and yet it may be said, that for all the use which is made of them, they might never have existed. And still this is not because occasions do not arise for their use, but because when the occasions *do* arise, practice is not there to assist.

If these facts point to any conclusion, they point towards one which

declares that our signals must not only be of the simplest possible character, but that great practice must also be provided for their use.

By "practice" I do not mean instruction. Instruction is *necessary* and most important, but it is useless to suppose that it will answer the purpose of keeping signalmen ready for emergencies. Continual useful employment for a signal system must be found, or the system will first fall into abeyance; and if, at any important moment called forth from its retirement, it will not justify any trust reposed in it. I do not mean to say that it is possible, or even necessary, in the furtherance of this object, to provide the self-same system for all occasions in the naval and military services; but I *do* say that the utmost care must be taken to limit the number of systems in use, and in the selection of systems to secure those which fulfil the greatest number of uses, even though they be but moderately efficient in each, to the exclusion of such as act extraordinarily well under certain extraordinary circumstances, but which fail under others.

Again, it is of the greatest importance that in selecting systems, that which requires least previous instruction should be carefully investigated, for, in spite of all precautions, signals sometimes must be used by persons unacquainted with them, so that the sooner a man *can* become acquainted with them, the better for the services.

I previously mentioned that I believed the use, or non-use, of a code of signals was considered a debateable point in many minds. The time has now come for discussing that point; but I really must beg pardon of my naval hearers for opening the question at all, for to us the mere idea of falling back upon an alphabetical, or spelling, system would appear simply absurd. To those unacquainted with naval signals, however, it is a commonly received opinion that it would be a great boon to the service, were it provided with some efficient means of sending messages by spelling. That a system is able to spell *at all* is, in the minds of such persons, a great desideratum, but they either forget, or are not aware of the fact, that there never was a system of signals invented, which could not be used to spell, if required. The question lies, then, not between spelling and not spelling, but between making a code, or spelling, the foundation of the system.

I before said that the primary object of a code of signals was to convey the greatest possible amount of meaning by the smallest possible number of signs. There is only one other object gained by a code—that is *secresy*, which I need not enlarge upon. The former object is gained, as previously stated, by ranging all the words, sentences, &c., in some order, and placing opposite to them certain letters or figures to represent them, which letters or figures do not generally exceed four in number. We thus get at least a whole word, and very often a whole sentence, expressed by four signs at the most; whilst to spell the same sentence would require perhaps four or five times as many. Such a sentence is, "Army is going to land;" expressed in the Boats' Signal-book by the figures 1594. To spell this message by the semaphore, would occupy, say at the rate of 7 figures per minute —which is full speed—3 minutes; to send it by the code only occupies

38 seconds. To this time, must be added that consumed in looking out the numbers in the code, both before sending, and after receiving, which will be about 16 seconds, so that on the whole operation, when the speed of transmission is 7 figures per minute, there is a gain of 2 to 1 in favour of using a code. There *is* a speed of transmission, probably about 30 figures per minute, at which the code falls in arrear; but I do not think that there is any system applicable to the general purposes of the army and navy which will attain that speed in practice.

I am quite aware, in saying this, that Captain Bolton has, with his Lime-light Flashing system, attained a speed *double* the above; and I am also aware that the electric telegraph trebles, and even quadruples, the speed mentioned; but these enormous speeds are the result of very great and constant practice, which practice, I feel pretty sure, will not be kept up, except by the use of the electric telegraph operators. It is natural, seeing that a spelling system is used all over the world with the electric telegraph with such success, to suppose that such a system is the most efficient for all purposes; but it cannot be too strongly pointed out that there is no ground of comparison between the use of the electric telegraph and "naval and military signals."

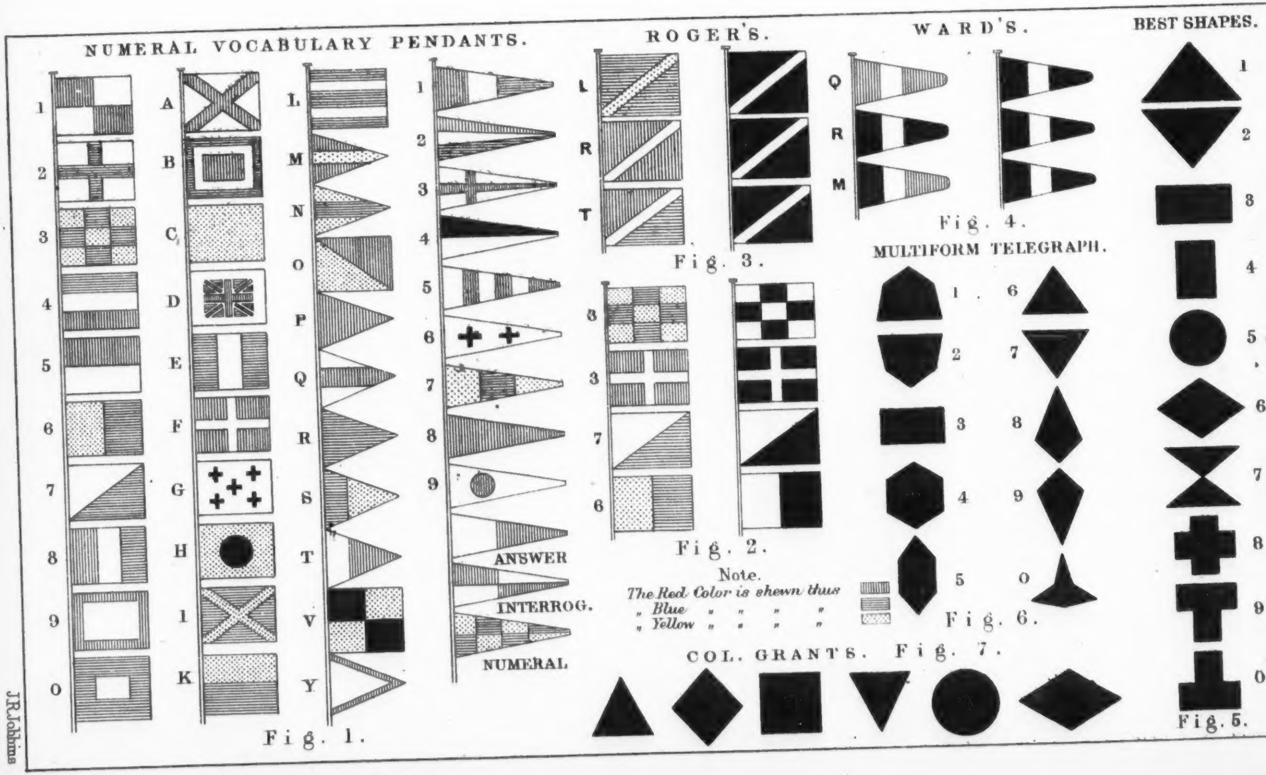
Signals by the electric telegraph are transmitted and received by operators seated in quiet rooms, with perfectly undisturbed attention. Naval and military signals are transmitted and received by operators exposed to the weather: it may be in the midst of confusion, personal danger, and every variety of disturbing cause. Again, the electric Telegraph has to convey the wants and wishes of the whole community—so various and opposite in character that to codify them would be an impossible task. Naval and military signals have to convey the wants and wishes of services, whose requirements are *special*, embraced in a narrow compass, and therefore offering remarkable facilities for codification. Nevertheless, when we get an Atlantic telegraph, a code will be an absolute necessity, as the signals are not transmitted at a greater rate than 3 or 4 letters per minute.* But, above all, stands the fact that a code requires a much smaller number of symbols than a spelling system. Captain Bolton, for instance, without providing for the use of a code at all, uses twice the number of symbols necessary to carry out my own flashing system. When signalling to a number of points at a time, the speed of transmission becomes enormously diminished, and the value of a code rises in proportion; indeed, it may be said that signalling to many points simultaneously, *cannot be* carried on without a code.

As far as we have gone we have seen:—First, that a "general system" for the army and navy is a desideratum to be sought for. Secondly, that this system is to be used with a code; that it must be the simplest possible; and that it must not depend on very great practice for efficiency.

Let us now proceed to the consideration of some of the systems already produced with regard to their fitness to fulfil these requirements.

I mentioned that the symbols used might be distinguished from one

* I have since ascertained that such a code was actually prepared.—P.H.C.


NUMERAL VOCABULARY PENDANTS.
1 2 3 4 5 6 7 8 9 0
A B C D E F G H I K
L M N O P Q R S T V Y
1 2 3 4 5 6 7 8 9
ANSWER
INTERROG.
NUMERAL
Fig. 1.
ROGER'S.
L R T
Fig. 3.
8 3 7 6
Fig. 2.
Note.
The Red Color is shewn thus
" Blue " " " "
" Yellow " " " "
WARD'S.
Q R M
Fig. 4.
MULTIFORM TELEGRAPH.
1 2 3 4 5 6 7 8 9 0
Fig. 6.
COL. GRANT'S. Fig. 7.
BEST SHAPES.
1 2 3 4 5 6 7 8 9 0
Fig. 5.

another by means of differences of form, colour, sound, or motion. I stated, also, that of systems depending on form and colour, those were the best which depended least on the latter. It will probably be said that all systems of signals by flags depend on colour. My answer is that whenever they do so, they are propriately inefficient, and that in the systems in commonest use, *colour* has very little to say to the matter.

In the flags shown—Fig. 1, Plate xxxv.—the numeral and vocabulary flags and pendants used in our navy, there are 5 colours employed—white, black, red, yellow, and blue. Of these, red, black, and blue are dark colours, whilst yellow and white are light. It is on the contrast between these dark and light shades that the distinctness of each flag depends.

Out of the whole number of 43 flags and pendants shown, there are but two cases in which the dark or light colours assume the same shape in two flags. In short, if only black and white were used, the flags would still be quite distinct from one another, which will clearly appear from Fig. 2.

In trying experiments on a small scale with these coloured and uncoloured flags, I find that with blue, grey, tree green, cloudy white, and black backgrounds, the uncoloured flags were, in all cases, most marked in their superior distinctness. Where errors occurred in reading, they were 3 and even 4 to 1 in favour of the uncoloured flags. Although these experiments were on a very small scale, I have tried others in actual practice bearing on the same point, and I see no reason to doubt that with flags as at present used, black may be employed to represent blue and red, and white to represent yellow, certainly without decreasing their efficiency, and probably with a great increase to it.

If a set of flags be constructed, in which the dark and light colours are arranged in the same form in each flag, it will be found that their range will be diminished one-half; and then the errors are frequent, and the difficulty of reading very great.

In corroboration of these facts, all signalmen and officers agree in stating that the flags most difficult to distinguish from one another are P and R, and N and Q.(Fig. 1, Plate xxxv.), and that those flags and pendants in which black and white only are used, are amongst the most distinct we have.

The first rule in the construction of flags is, therefore, to take care that the form of the dark and light colours in each flag is as different as possible: the second, that the dark and light shades be disposed in the largest masses attainable. Negative evidence on this head is shown by the fact, that the letter D is the worst flag we use in the navy. The shape of the flags themselves may also be varied with advantage.

Doubtless, many naval officers who hear me, will say that it is a waste of time laying down rules which are generally understood. I reply, that there are in use now numbers of sets of flags in which these principles are utterly ignored, and in one recent proposal, a special merit is made of ignoring them.

America, in my opinion, produces two of the worst sets of flags to be found—Mr. Rogers' and Mr. Ward's. Mr. Rogers' are, I believe,

used by American shipping; but I am not aware that Mr. Ward's have come into practice yet. In Plate xxxv., Figs. 3 and 4, are shown three of Mr. Rogers', and three of Mr. Ward's flags, with their counterparts in black and white; these diagrams will at once expose the falseness of the principles on which these flags are constructed. Mr. Rogers' flags are, however, comparatively efficient when placed beside Mr. Ward's. It really would seem that in devising this arrangement of flags, special preparation had been made for as large a number of errors as possible. Seven or eight flags done in black and white, will represent every one of the 27 in the set, and a simple black flag will stand for no less than eight of them.

There are other systems of flags used by continental nations, which are nearly, if not quite, as faulty as the foregoing. Italy, for instance, makes 10, and Belgium 12, out of 18 flags depend exclusively on colour. Austria is remarkable as being the only nation which employs *green* in signal flags. All flag systems are "general" ones; the flags are displayed in groups of three or more, hoisted over one another where they can best be seen; and they are in all cases read from the top, downwards.

The disadvantages which are urged against systems of flag-signals, are the following:—first, it is said that their dependance on colour renders them peculiarly liable to mistake, especially by persons labouring under the very common defect of colour-blindness. I have shown, I hope, that there is no need that this objection should exist to any appreciable extent.

Next, their inefficiency in calms, or when the wind is blowing directly from, or directly towards, the observer, is laid great stress on. I am much inclined to think this fault is exaggerated. It is quite true, that in a perfect calm, signalling with flags is extremely difficult. But a perfect calm is of very rare occurrence. At *sea*, it may be asserted that there is no such thing; for the motion of the ship generally creates breeze sufficient—when rolling from side to side—to distend the flags. In close harbours, and sheltered portions of the land, calms, such as to delay flag-signals, are of more frequent occurrence; and certainly, that fact merits careful consideration. When the wind is with, or against the range of signals, the legibility of flags is diminished, but never destroyed, as the direction of the current of air varies every now and then, and exposes more of the surface of the flags.

But a third objection lies in the number of flags it is necessary to provide, to make the system efficient. With a set of 10 flags, numbered from 1 to 0, instead of being able to go steadily on from 1 up to 9999, using no more than 4 flags at a time, all the groups in which the same flag appears *twice*, must be omitted, and this reduces the number of signals by nearly one-half. To obtain the full amount, it is necessary to add at least *three* additional flags, which are called "repeaters," and which become substitutes for the first, second, or third flags in the series.* The Committee of the Board of Trade, appointed in 1856 to arrange the mercantile code of signals, condemned the use of "re-

* An instance is given in Plate xxxv., Fig. 2, when flag F is used to repeat the upper 3.—P.H.C.

peaters," and employed 18 symbols, representing letters of the alphabet, without them.

This difficulty of reducing the number of symbols required to be used and committed to memory, is one common to most general systems of signalling by means of form or colour, and should not be specially charged against flags; in signals by motion, it is avoided in a great measure.

The nature of the ground will, in military signals, very often interfere with the display to a distance of any symbols. This may possibly be obviated in flag signals—the symbols being so light—by the employment of small balloons to carry the flags up to the required height.

The superiority of *form* over *colour* as a means of signalling, is a fact which has led to a good deal of misapprehension. It has first led persons to suppose that flag-signals depend on colour, as I have explained; and next, it has raised an idea that great improvements might be made by the introduction of solid colourless bodies as symbols, to be used in the same manner as flags.

The supposed advantages to be derived from this arrangement were, first, the non-use of colour; and secondly, the use of symbols which presented the same appearance in every direction unaffected by weather.

On the first blush of the matter, it would seem that solid shapes thus constructed, *must* carry all before them, in distinctness. But a little examination shows that the case is not so strong. To fulfil their purpose, the symbols must be so constructed, that every horizontal section of each is a circle; and this at once limits the number of forms it is possible to construct.

It is, in fact, most difficult to arrange a sufficient number of forms on this principle, to work even the simplest codes. There is the cone, the drum, and the sphere; and all the figures to be made, must be but modifications of these. The least number of signs by which the ordinary codes can be worked is 13, and a little consideration of Fig. 5, Plate xxxv., will show how difficult it must be to provide that number of distinct solid figures.

In order to draw a comparison between these solid shapes and the ordinary flags, we must erect some standard as to area, before our comparison can be completed. I think that the symbols to be compared should occupy the same perpendicular height in display; for if our solid shapes are to occupy a greater height than the flags, to attain the requisite distinctness, there is no reason why the flags should not also be increased in size.

Now, if we take a set of solid shapes, such as are given at Fig. 5, Plate xxxv., with the above limitation to their size, we shall find that if there *is* a gain in distinctness in using them, it is exceedingly difficult to trace.

With light, unbroken backgrounds, such as sea and sky, when the direction of the wind is at an angle of 45° to the line of vision, *some* of these solid figures have an advantage over flags. But with dark, or broken backgrounds, there is hardly any advantage, and in many cases, a complete disadvantage. For it must be recollected that the visibility of flags depends on the contrast between the dark and light

colours of the flags themselves; whereas with solid shapes, the contrast is between the solid shape and the *background*, which thus becomes a more material element in one case than in the other. But even supposing that the advantage of solid shapes were much greater than it is, they have, when used in the ordinary way, disadvantages of their own, in their cumbrousness, weight, and size.

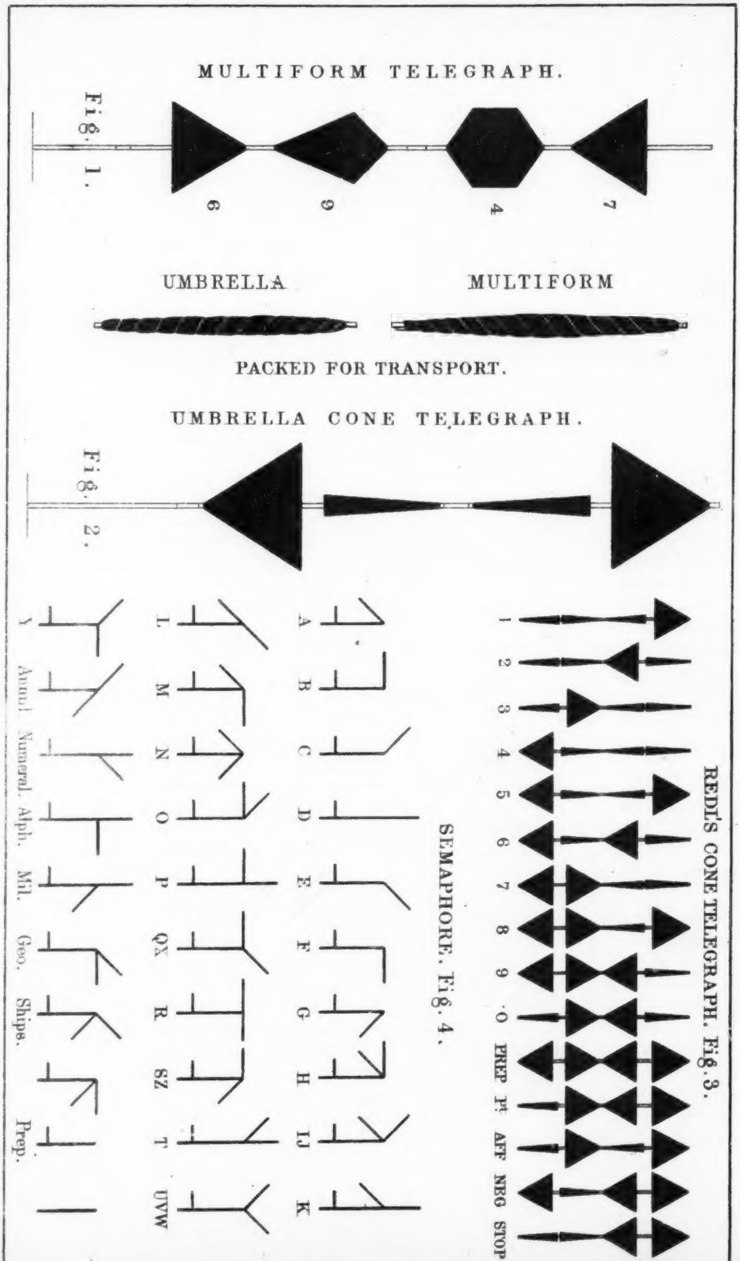
Principally to get rid of these latter difficulties, sacrificing some range for extra convenience, I invented what I call the "Multiform Telegraph," and which is represented in Plate xxxvi., Fig. 1. Each of the four covered frame-works is capable of assuming 10 different shapes (Plate xxxv., Fig. 6), so that the ordinary provision for the repetition of similar numbers is not required; and the apparatus is capable of displaying more than 12,000 distinct changes, visible to every point of view. According to the rules I have laid down, I find that, at $2\frac{1}{2}$ miles compared with flags, the error in reading is as 8 to 3, the speed being at that distance equal. At closer range, when the error of both systems is *nil*, the speed of the multiform telegraph is double that of the flags. This, and the extreme portability of the instrument, are its advantages. It folds up into three parts by means of a jointed pole, and is then easily carried by a man. The changes of figure are produced by lines reaching to the base of the pole.

A Mr. Gower, in the East India Company, seems to have been the first to propose solid forms for signalling. Next came Colonel Grant, who patented, in 1838, the system of form-signals shown in Plate xxxv., Fig. 7. More recently, Captain Brown, the late registrar-general of seamen, proposed the use of similar figures as "battle-signals." It was supposed that, in the smoke of action, they would be more legible than flags, and about ·20 special signals were to be set apart for their use. Even supposing the advantage of visibility to be greater than I believe it, I should doubt the use of special appliances, only to be used on special occasions. I fear that, when required, such things are never in their places.

We have now discussed the chief characteristics of form and colour, as used in "general" systems. We must consider them with reference to telegraphic systems. There is no system of this kind involving colour for day-signals, and there are but two dependent on form which merit attention. These are the semaphore and Redl's cone telegraph. The semaphore is simply a tall post, at the top of which are two arms, moveable in vertical circles. They are moved by means of chains or other appliances from the bottom, and each arm is capable of assuming 7 positions, giving 27 changes in all to the instrument (Plate xxxvi., Fig. 4).

The signals are transmitted like all telegraphic signals, figure by figure or letter, and each figure or letter is usually repeated by the other station. The defect charged upon it is, that the signals can only be made in one direction; but as it is a telegraphic system this is not really a defect, as it could not in any case be efficiently used to a number of points.

On the principle of the semaphore are established several systems, by means of which a single man may transmit intelligence to con-


MULTIFORM TELEGRAPH.
Fig. 1.
6
9
4
7
UMBRELLA
MULTIFORM
PACKED FOR TRANSPORT.
UMBRELLA CONE TELEGRAPH.
Fig. 2.
REDL'S CONE TELEGRAPH. Fig. 3.
1 2 3 4 5 6 7 8 9 ·0 PREP Pt AFF NEG STOP
SEMAPHORE. Fig. 4.
A B C D E F G H IJ K
L M N O P QX R SZ T UVW
Y Annul. Numeral. Alph. Mil. Geo. Ships. Prep.

J.R.Jobbins.

siderable distances. The arms, with or without other objects to assist, are placed at different angles to the body, as, at right angles, over the head, &c.; so that 16 or 18 changes are arranged—sufficient to make, figure by figure, almost any signal. Each figure made thus is still supposed to be repeated, or otherwise acknowledged. Two or three systems of this kind have been arranged by Captain Wilmot, and there is a similar one by Captain Reynold, of the French navy. None of them, however, have been much used.

Hitherto we have treated of systems of signals used with different apparatuses, and each requiring separate study. Now we come, for the first time, upon a system, certainly having its own apparatus as a foundation, but being perfectly applicable besides, as far as a telegraphic system can be, to any objects, under any circumstances, and without requiring any additional study after the system is once learnt.

This beautiful arrangement is "Redl's Cone Telegraph," provisionally adopted as the army signal system, and the pioneer of that universal applicability of system to all purposes, which will, unless I am mistaken, shortly assume a great importance.

Redl's apparatus originally consisted of four cones or other bodies, joined in pairs at their bases, which were formed of large hoops. The cones were collapsible into these hoops, and the apparatus as then constructed, required a mast and yard, or gaff, to which the cones were hoisted.

When I turned my attention to the matter for military purposes, it appeared necessary to adopt some simpler arrangement. I therefore constructed sets on a pointed pole, closing round the pole like umbrellas, as is shown in Plate xxxvi., Fig. 2.

The cones, four in number, are made self-collapsing by means of springs, so that each cone is opened by a single line, four being required to work the whole. The cones are numbered from the top, 1, 2, 3, 4; thus, when the 2nd cone is open, it signifies 2, the 3rd, 3, etc. Then 5 is made by displaying the 4th and 1st cone, 6 by the 4th and 2nd, and so on, as in the diagram (Plate xxxvi., Fig. 3).

Other changes are necessary in signalling, such as "Preparative," all the cones open, and more of the like nature, making 15 changes in all.

As the cones were originally used, every change required repetition from the station receiving it. In order to make the system more closely approach a general one, I introduced the practice of repeating merely the "stops" at the end of each series; and this is the practice now, as it answers perfectly well between fixed positions, and renders the signalling more rapid than it otherwise would be. Thus, to make the signal 478, "Enemy is advancing with infantry" (Boats' Signal-book), the preparatory signal must be answered, and then no other answer is required till the "stop" after the 8. By this plan, the speed has reached 24 figures per minute.

The arrangement of the alphabet is extremely good, and should be adopted in all cases where it is necessary to turn figures into letters. A is numbered 5, and the rest of the letters follow in order. If A

were numbered 1, the figures 13 would equally represent A, B, and M, hence confusion would arise; but by making A = 5, the figure 1 can never represent a letter by itself, but must belong to the figure which follows it.

We must now turn to the universal application of this system to any visible symbols, or any sounds.

There are two states in which each cone can rest—closed and open. If, then, we say that one thing—no matter what—represents an open cone, and another thing represents a closed cone; if we run through the series of four changes, we can express the 15 variations of which the apparatus is capable. Suppose the right arm to represent an open cone, and the left a closed one; if we raise the right arm *once*, the left *twice*, and lastly, the right *once*, we shall have expressed—1st cone, open, 2nd shut, 3rd shut, 4th open, or the figure 5.

So with any two things, a black and a white ball or flag, a hat and stick, a short sound and a long one, a single and double sound, a low and a high note; any two things, in short, no matter what or where they are.

But the most striking thing in the system is, that it is by no means necessary to pre-arrange the objects or sounds to be used. The "Preparative" must in all cases be made, to attract attention, and thus the symbol representing the open cone is fixed by both parties, and the rest of the signal can go smoothly on.

I have constantly been in the habit of using this system; but I recollect one striking instance, whilst I was in the Channel Fleet, in 1859.

The fleet was at Portland, and going for a walk on the Bill, I had directed the signalmen of the flag-ship to look out for me. Some hours afterwards, I thought I would test their alertness, and so made the "Preparative" with a pocket handkerchief, about a mile off. I was some time getting an answer, and then it came from another ship. I directed this ship to tell the flag-ship's signalmen where I was. This ship did so by means of her cones. The flag-ship's signalmen then apologised to me by means of their cones, and I in return, by means of my umbrella and pocket handkerchief, gave them a sharp rap over the knuckles, and bade them keep a better look-out next time.

As to the relative merits of cones and flags, there ought not to be anything said, as the one is a general, and the other a telegraphic system. The relative range, therefore, of the two systems, depends entirely on the size of the cones used, which again depends on mechanical or local considerations. Cones with 3-feet base and side, transmit signals five miles with great rapidity and facility; and this is the size adapted for field purposes in the army.

The mechanical construction of the apparatus is one of the gravest difficulties the system has had to contend with. I am by no means satisfied with any of the many arrangements I have perfected, either for fixed or field stations; and, notwithstanding my admiration for the system, I fear it will not retain its hold in the army; and this irrespective of the question whether *any* entirely telegraphic system can be depended on for army uses.

I should feel more regret in holding this opinion, were I not confident that the cone system opened the gate, so to speak, of signalling. I think I shall be able to show, at my next lecture, that by making a considerable advance on what we have discussed to-day, especially with reference to Redl's arrangements, there are means whereby all the simplicity and comprehensiveness of his system can be retained, without a single one of its disadvantages.

Monday Evening, June 1st, 1863.

W. STIRLING LACON, Esq., in the Chair.

NAMES of MEMBERS who joined the Institution between May 18th and 1st June.

ANNUAL.

Guise, J. C., Lt.-Col. 90th L. I. Fuller, T., Lieut. 18th Hussars. 1*l*.

NAVAL AND MILITARY SIGNALS.

By Lieutenant P. H. Colomb, R.N.

Part II.

Night Signals—Signals by Motion.

In the course of my last lecture, I endeavoured to show that all signalling was conducted on one of two great principles: first, the "general," where the symbols composing a signal were displayed in groups, in such a manner that each group was complete in itself, conveying either a word, sentence, or order, to every station, in every direction, so that *one* answer from each station was a sufficient acknowledgement to ensure the correct reception of the message. The characteristics of this mode of signalling were the number of symbols it employed, and the slow speed with which group followed group; but, at the same time, its admirable adaptation to the purpose of addressing several points simultaneously.

On the other hand, there was the telegraphic system, which, inasmuch as it only displayed one symbol at a time, and required a separate acknowledgement of each symbol displayed, from each station, was *not* calculated to address more than one station at a time.

In addressing a single station, however, we saw that owing to the rapidity with which changes could be made, the speed of a telegraphic

system was, in all cases, vastly superior to that of any general system. We also saw that all signals were conveyed by means either of *form*, *colour*, *sound*, or *motion;* and we entered slightly into the relative merits of the first three, and showed some of their applications. Colour, we found, was but little used, and form much.

We are now to see the application of these principles to night-signals, and then we have to treat of the last and most recently applied principle—motion—to all signals, both day and night. And, to sum up all, I shall endeavour to state, in few words, what I propose as improvements, based on the evidence previously put forward, on the methods of naval and military signalling now in use.

If I commence operations to-night by asserting that signalling by night is both more ancient and easier, properly speaking, than signalling by day, I must ask my naval hearers not to think me rash in such an assertion, until they have heard my reasons.

Many officers, with a vivid recollection of old battered lanterns, broken glasses, heavy signal-yards, confused signalmen, and dazzled eyes, a puzzled turning over of the leaves of the night-signal book—only half under shelter from sea and rain—will, perhaps, smile at my supposed ignorance of the difficulties to be contended with. I can only say, I join in their smile, because I hope such difficulties have now lost their force.

Thousands of years before there appears to have been a complete system of day-signals, there were at least two by night. These two are both described by Polybius, the latter of the two being partly his own invention.

The first system, which nowise resembled any of the more modern ones, might be called "the pitcher system," and was thus arranged:—The two stations between which signals were to be conveyed, were each supplied with a tall pitcher filled with water; a small tap was fitted to the bottom of each vessel, so that on opening them, the water might run out of each at the same rate exactly. A piece of cork was set floating in each pitcher, and into each cork was fixed a long slip of wood. These slips were marked out into as many divisions of three finger-breadths as there was room for, and on each division a sentence likely to be used in time of war was inscribed. Each station being provided in addition with a torch ready for lighting, was in a position to commence operations after dark.

The station wishing to send one of the messages inscribed on the sticks, first showed a lighted torch, and kept it displayed until answered by another. Then the first station opened the tap of the vessel, and dropped the torch, which was the signal for the other station to do the same. Both corks and sticks were now descending, at the same rate, so that, as soon as the sentence required to be transmitted reached the level of the vessel at the first station, the tap was stopped, and the torch again shown, so that the second station might do the same, and read off the message.

The second system described by this writer, and which is certainly quite as efficient as many of more recent date, was thus carried on:—

Each station wishing to signal, prepared five pieces of wood, on which

the letters of the alphabet were written in their proper order—five on each slip, except the last, which contained four. The station commencing, first showed two torches as a preparative, and then the message was spelled as follows:—torches from one up to five, displayed on the *left*, referred to the number of the tablet, and then so many to the *right*, the number of the letter on that tablet. The letter delta would then be signified by 1 torch to the left, and four torches to the right, and so on throughout the course of the signalling. So far for the antiquity of the practice of night-signalling; now for the remainder of my assertion that it is essentially easier than signalling by day.

The above-described systems were certainly capable of conveying messages four or perhaps five miles; for torches in a clear atmosphere would be quite visible at that distance by the naked eye. Now by what possible arrangement could signals be made visible at that distance in the day time. The objects used to represent the torches must have been of great size and very unwieldy in consequence; requiring, in fact, a special apparatus to work them. In short, it is only because the invention of the telescope has increased our power of vision that we have been able to put our signal apparatuses in the day time into practicable shape. But it will be said that, owing to the use of this instrument, night-signalling has been thrown into the shade. But even this is not strictly true. Nine or ten miles is the extreme range for flag signals with good telescopes. For Redl's cones, six feet in diameter, the average is something greater, whilst for the ordinary semaphore it is, I believe, something less.

Now I have used signals with Way's electric light at sea in half a gale of wind, without any difficulty, and with the naked eye, at twelve miles. Ten miles is but a moderate range for the lime-light signals, as used by Captain Bolton, whilst I have seen the flashes of the light distinct enough for reading at thirty-five miles. With my own night-signal system a glass is rarely used up to 4 miles, although the light is of the ordinary kind. Flags at that distance are not even *visible* to the naked eye. Now we learned during my last lecture that the greatest speed attained by any system of day signals has been twenty-four figures per minute, at short range, with Redl's cones. This speed cannot be kept up at longer ranges, or with larger apparatuses. Captain Bolton ordinarily secures a speed which is double this; and, if the power of light be increased, there ought to be no diminution of this speed to ranges approaching twenty or twenty-five miles. In my arrangements I purposely keep down the speed of my signals, as I am content to secure a speed at least equal to our ordinary signals in the day time. Thus we see that, both as to range and speed, the night-signal apparatuses now existing are far beyond any that have been devised for day-signals; and thus I claim to show that on the face of the question, signalling is easier by night than by day.

The great difference between day and night-signalling consists in the fact that day signals are conducted by reflected light, and night-signals by generated and transmitted light, and a few words as to the different modes of generating and transmitting light for the purposes of signalling may not be amiss before we proceed further. The subject

is divided into two parts:—the generation or production of the light, and the economization of its rays to the purposes required of it. The most common mode of production is by the combustion of oil in a wick. Oils become inflammable at certain temperatures, and the use of the wick in an oil lamp is to expose the fluid in particles small enough to acquire this heat on reaching the flame. The combustion of the wick itself is, in all cases, to be avoided as much as possible, for it has nothing to do with the production of the light.

In order to secure the perfect combustion of the gas generated from the heated oil, a large supply of oxygen is necessary; if, then, the gas is generated faster than the oxygen can reach its surface, it passes off in smoke, and so much loss of light, with so much waste of material, takes place. The Argand burner is arranged so that the supply of oxygen from the air shall be very rapid. By means of the chimney, the air heated by the flame passes rapidly upwards, whilst other fresh air rushes in equally rapidly on the surfaces of the flame, and there its oxygen mingles with the gas, and produces continued combustion. In fact a permanent bellows is set up upon the flame, which produces precisely the same effect as an ordinary bellows on a blacksmith's fire.

Keeping these principles clearly in mind, we find we can vary the *modus operandi* to any extent. It is in fact only necessary that a current of air sufficiently rapid, be directed on the proper part of the flame, to secure all the conditions of the Argand burner. Thus in many of the newer descriptions of lights, especially the parafin, or hydro-carbon oil lamps as they are called, it is beginning to be perceived that the inconvenient glass chimney, always breaking and always smoked, may be done away with, securing thereby economy and convenience, without any loss of light. In fact I believe there is no light now using glass chimneys which might not burn equally well without them.

For signal purposes, the difficulty with all these lights formed by the combustion of oils in contact with a stream of atmospheric air, is that exactly in proportion to the perfection of the combustion, and consequent purity of the light, so is the want of capacity to resist the changes of pressure caused by currents of air outside the lamp.

Take a moderator lamp off your table into the open air on what you would call a comparatively still night; you will find that the flame at once begins to jump and flash, and at last—probably in a very few minutes—suddenly disappears. In a parafin lamp, the tenderness, so to speak, of the light is even greater, and is, in fact, almost impossible to overcome.

These difficulties arise from the fact that the lamps require the current of air to impinge on the flame in a particular way; as long as the up-current is sufficiently strong to resist pressure and make its way, all goes right, but the moment the pressure becomes too great for it, the current is reversed, and the light goes out.

The result of this state of things is that the difficulty as yet remains unconquered, and all oil lights which are exposed in lanterns to the weather, give up anything like perfect combustion, use no glass chimneys or other contrivances, and permit much of the gas to pass off in smoke.

Candles for signal-lamps are, as a rule, more satisfactory than oil. There is a limit to their power, as you cannot receive a better light from them by any direction of the air current, but as they require no trimming, are cleaner, and require less care in the management, so they are more in favour in the navy than any arrangement of oil lamps.

These are the ordinary modes of generating light for signal purposes.

The next light proposed to be employed is the lime light, which, under Captain Bolton's able arrangements, has justly gained a footing as part of our military system. I need not here describe the nature of the light, as it has already received clear explanation at Captain Bolton's own hands.

The objections to the light for signal purposes are the following. In the first place; as it requires three elements to be in perfect order, the failure of any one of these brings the whole light with it. The production of two gases is a matter of care. The light when burning requires constant manipulation, and can therefore only be used in situations where this is attainable. If the light is required to be displayed to every point of the horizon, not less than three jets of the gases are required, thereby complicating the arrangements.

The advantages of this light are, that when its rays are only required in one direction—as now used by Captain Bolton—and where such intense light is necessary, it is not so complicated as other powerful lights.

There are two kinds of electric light before the public; that using carbon points, and Professor Way's. The principle of the former, which has, with the lime light, been exhibited in this room, is that of the original invention; namely, two points of carbon kept at a certain regulated distance apart, whilst a stream of electricity is allowed to flow from one to the other; the light, the most intense for its size known, is produced in the interval between them, and is consequently visible all round the horizon.* Mr. Holmes' special arrangements consist in the adaptation of a self-regulating apparatus of beautiful construction, whereby the charcoal points, as they are consumed by the heat, are made to approach each other, so as to secure the regulated distance; and also the employment of a mechanical, or magneto-electric battery to produce the current, instead of a chemical one.

The other electric light, Professor Way's, depends on what is called "flowing electrode." It consists of two reservoirs, an upper and lower, the upper being filled with mercury, and completely insulated from the lower. The upper reservoir terminates downwards in a jet of fire-clay, whose orifice is only large enough to admit a very fine needle. A stop-cock regulates the supply of mercury to this jet, which supply when allowed to flow, passes through the orifice, and falls into a small cup immediately below it, in connection with the lower reservoir. The upper and lower reservoirs being connected with the positive and negative poles of the battery, the light is produced just where the mercury breaks into drops.

Mr. Way has hitherto used only the chemical battery with his light;

* For further particulars see Journal No. XXVII, page 241. Et. seq.—Ed.

but I must say that having rather closely investigated the matter, and having carefully examined and experimented with both descriptions of lights, I am of opinion, that no useful result is to be looked for by the use of a chemical battery. I am inclined to think that a judicious combination of the flowing electrode and the magneto-electric battery, will be found to place the electric light in a more prominent position as to practical usefulness, than it has hitherto held.

The time does not appear to have yet arrived for the employment of any of the before-mentioned lights for the signal operations of our fleets; but I do not think we ought to shut out the possibility of their employment, at a future time, from our view.

There is a light of very recent production, which I am inclined to think will be very largely used for signal and other purposes in our fleet. I allude to Mr. Goldsworthy Gurney's oil gas, which is now in use, I believe with perfect success in H.M.S. "Resistance."

This light is simply the employment of the destructive distillation of oil in a small retort, to produce a gas which is perfectly pure and fit for use as it comes over. There is no necessity for a gas-holder, but only for a small governor on the principle of the gas-holder to regulate the supply and pressure of the gas.

The generating apparatus is very small and portable, and the whole of the fittings inexpensive, and seemingly practical. The gas is used precisely as common coal-gas; but it is said to be a purer flame, and, therefore, more powerful. If it be required to produce a more intense light than that given by the simple gas, Mr. Gurney introduces a jet of oxygen, in the manner of his Bude light, which secures a flame of the most vivid and dazzling brightness. The Bude light itself, as I daresay is known to most of my hearers, is simply an arrangement for feeding the flame of an oil, or other lamp, with pure oxygen in lieu of atmospheric air, thus obviating the neutralizing effect of its nitrogen.

The foregoing is a very imperfect sketch of the different modes of generating light now before the public, and more or less available for signal purposes.

We now come to the economization of the rays produced by the different modes of generation, so as to apply them in the best manner to the purposes of signalling.

Considering a light as the central point, the rays produced by it radiate equally in all directions, so as to illuminate uniformly every portion of a hollow sphere of which the light forms the centre. An observer, therefore, looking at a naked light, receives but very few of its rays on his retina; and the greater the distance, the smaller the number he receives; the number evidently varying as the square of his distance from the light. The great mass of the rays of light pass above, below, or on both sides of him, or not in his direction at all; consequently, as far as he is concerned, the whole of the light, except the very small portion striking on his retina, is lost. The economization of the light for signal purposes, merely consists in bending those otherwise useless rays of light, so as to direct them into the observer's eye.

If the light is required to show all round the horizon, all that can be done is to bend the rays which pass upwards and downwards, and send them out parallel in the form of a disc. The observer still loses the rays which pass on each side of him; but this is, of course, unavoidable.

If, however, it is intended to direct the light in one direction only, every ray of light may be sent into that direction, so that they form a bundle of rays closely pressed together.

The sending of the rays is accomplished by means of refracting lenses, termed the Dioptric system; of reflectors called the Catoptric system; or a combination of both, called Cata-dioptric. By either of these means, comparatively weak lights are rendered more or less powerful, according to the amount of compression to which the rays can be subjected without interfering with the use of the light; so that the light of a lamp, whose rays are bent into a cylinder, will penetrate to a greater distance than those of one of the same power which are only sent into a disc.

We have seen that many difficulties lie in the way of greatly improving the generation of artificial light for signal purposes; and on this account more attention has been given to its economization.

The bar in the way of using lenses and reflectors for signal-lights is the great size of the flame when compared with the size of the lantern and lens. This renders an approach to mathematical correctness a matter of great difficulty. Thus it is, that an approximation only to correctness of form in either is aimed at. I am far from saying that this approximation may not be more closely drawn, but that it can only be an approximation, has much retarded progress in this direction.

Three kinds of lenses are generally used for signal-lights—plano-convex, double convex, and polyzonal. The plano-convex is by far the most commonly used, and next to it the polyzonal, founded on it. The plano-convex lens for signal-lanterns, is the cheapest and easiest of manufacture; but I think, from its shorter focal distance, in proportion to its thickness, that the double convex lens is that most applicable to signal-lanterns.

There is no practical advantage gained by the use of the polyzonal lens, except the decrease of weight, and slight increase of light, consequent on the diminution of the thickness of glass. The actual refraction produced is, of course, the same, mathematically speaking, as that produced by a simple lens of the same nature. For signal-lanterns, I prefer the plain lens to the polyzonal, for many reasons, the principal being that the edges of the zones are liable to be chipped and broken; and the cavities between the zones are difficult to keep properly clean.

Lenses only are used when the signal-lights are required to show all round the horizon. When, however, their light need not penetrate over more than a small arc of the horizon, reflectors of various shapes are brought into play. If the rays of light, after reflexion, are to pass through a lens, the form of the reflector must be a portion of a sphere, reflecting the rays from the light, as the centre of the sphere, directly

back to it, so that they may radiate and fall on the lens in the same manner and direction as the unreflected rays from the light. Theoretically, under these circumstances, the power of the light is doubled by means of the reflector, subject to the absorption of light by the reflector itself. Theory and practice, in the case of signal-lanterns, do not go hand in hand. It is almost impossible to secure the continued brightness of a reflector so placed; and with most cata-dioptric lanterns—such, for instance, as the naval mast-head and bow lights—the absence or presence of the reflector is almost a matter of indifference. If the rays of light are not to pass through a lens after reflection, the reflector used is formed by the revolution of a parabola round its axis, when the light is to issue in a cylinder, or round its focus when it is to issue in a disc.

Now the difficulty in making use of these different methods of economizing light for the purpose of *naval* signals is the effect of the motion of the ship altering the horizontal direction of the disc, or either the lateral or horizontal direction of the cylinder of light. It is evident that if a light, furnished with lenses or reflectors, be made a fixture in a ship, in smooth water, or nearly so, the light will appear steady to an observer at a distance; but if the ship be in motion, the disc or cylinder of light will form, so to speak, a long arm or lever, of which the ship is the pivot. If a disc of light, it will pass above or below the observer's eye, according as the ship rolls from or towards him, and the light will only appear just at those moments when the ship regains her upright position. It must be manifest that signalling of any kind will be, to say the least, extremely difficult under such circumstances as these. I may go further, and say that experiments have shown me that it is all but impossible; and yet this is one of those important points which has been entirely overlooked by all signal inventors who have used lens lights. The only mode of obviating this defect is by placing the lights used, upon gimbals, with just sufficient friction to allow the lamp to avoid the motion of the ship, and no more. If there be too little friction, the lamp assumes a vibratory motion of its own, over and above that of the ship, and at once redoubles the difficulties of the case.

For military purposes the question of the economization of light appears to have the following bearings:—in addressing a single point at night, each light or lights can be specially directed at that point, and, as they are fixed, there is no further difficulty after the direction is ascertained. But in addressing a number of points simultaneously we are met by a difficulty which does not exist at sea. The water being a dead level, observer's eyes are always at the same height, or nearly so, with the lamp; therefore, light from it, projected in a horizontal disc, must reach them. The surface of the ground is, in most cases, very far from being on a level, and if the different stations to be addressed simultaneously are not carefully selected, which they very seldom can be, no arrangement of lenses will project light equally to each of them. I have, to a certain extent, obviated the difficulties attached to this question of lights for signals, by making use of pyrotechnic light in a peculiar apparatus. The light produced is very bril-

liant, is not liable to derangement from weather; the apparatus is very portable and compact, not very expensive; and as no lenses or reflectors are used, none of the difficulties pointed out affect it.*

Bearing in mind the remarks I made at the commencement of my lecture, we are now in a position to discuss the question of night-signals by *form* and *colour*.

Signals by form—that is, lights of one colour in different positions, constitute the basis of the night-signal systems of all the navies in the world, except the Russian. They are, therefore, brought into a prominence which no other methods occupy; but I am inclined to think that their day has nearly passed away. We know that flag signals, when first introduced into our navy, were quite arbitrary and unsystematic in character. In 1710, the Union Jack at the fore meant "tack in succession," and a red flag at the mizen meant "Bring to on starboard tack." Signals so made were few in number, and were added to, and used in the same unsystematic manner for a century. Now, at the same time, for night signals, it was only natural that precisely the same course should be adopted with the means most readily at hand. What was easier than to say that, if in the daytime a Union Jack at the fore meant "tack," two white lights at the ensign-staff should also mean "tack." Then four lights horizontal might mean "bring to on starboard tack," as the red flag, in the daytime did, and so on for the few signals then considered necessary. The system by night then went as far as the system by day, or nearly so; and the extension of either would have been put aside as useless.

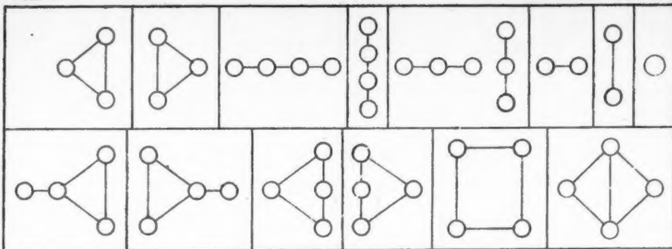
But as time drew on, greater regularity and greater discipline in the management of fleets became a necessity. A greater number of signals were required, and it was found that by attaching a separate number to each flag which was already in use, they could be employed in a very large number of combinations without in the least confusing them, but in reality rendering the practice of signalling easier than it had been under the old arbitrary arrangement.

But then arose the question of the commensurate extension of the night-signals, and at once a serious obstacle was encountered. There was no difficulty in calling the tacking flag 1, and the red flag 2, and hoisting both of them together to signify either 12 or 21, and to attach new meanings to each of these combinations; but how were they to hoist 2 lights vertical over 4 lights horizontal, or the reverse? What possible number of lights, or what extent of hoist would be required to re-arrange the system on this principle? or how was any observer to understand the meanings of such confused masses of lights?

Here lay the difficulty. There was no limit to the variety of flags which might be devised, and there was hardly any limit to the number of combinations possible with them; but the limit to the number of forms of lights was already reached, and it was not possible to use them as combinations at all.

This has been the rock on which our night-signals split, and it may with absolute truth be asserted, that we have gone back in the matter,

* For further information on lights, see Journal, No. XXVII.—P. H. C.

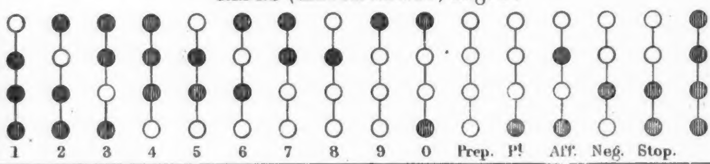


NAVAL NIGHT SIGNALS. Fig. 1.

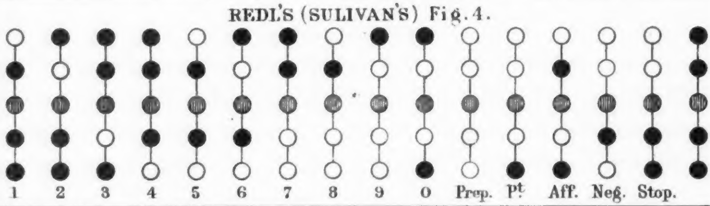
COLORED LIGHTS Fig. 2.

Note. *The Red Color is shown thus*
" *Green* " " " "

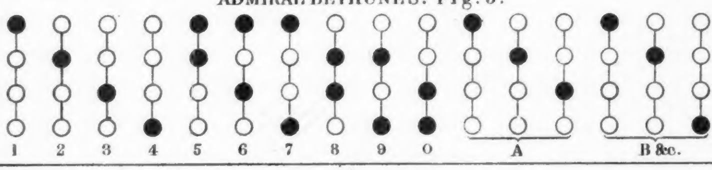
REDL'S (HAWTHORNE'S) Fig. 3.



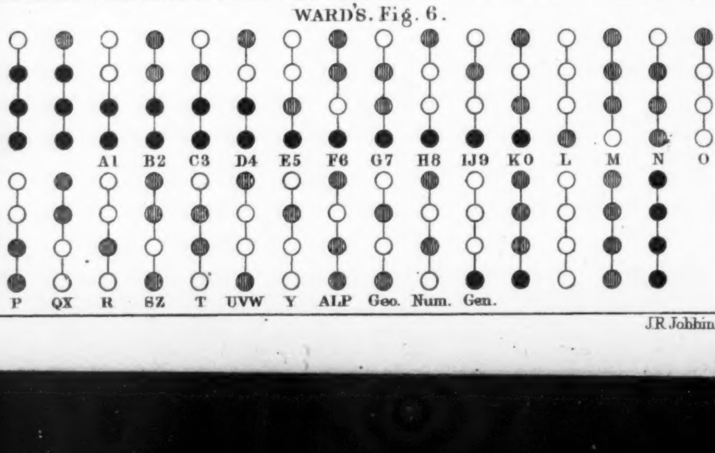
REDL'S (SULIVAN'S) Fig. 4.



ADMIRAL BETHUNE'S. Fig. 5.



WARD'S. Fig. 6.



JR Jobbins.

and our naval night-signals *now*, are more inefficient than they were in the middle of last century. They are, indeed, so bad, that a flag-officer recently in command assured me, that he dared not make more than 6 out of the 103 signals in the night signal-book, so much less were the chances of error with no signals at all, than with the naval night-signal system.

Simultaneously with the numbering of the flags, the plan adopted to get over the night-signal difficulty was this:—1 light meant one, 2 lights two, 3 lights three, 4 lights four; then 5 was represented by false fires in any number; 1 gun meant 10, 2 guns 20, 3 guns 30.

Each night-signal set down was then numbered as the day signals, from 1 upwards. The signal 21 was made by two guns for 20, and one light. The signal 17 by one gun for 10, false fires in any number for 5, and 2 lights for 2, making 17 in all. This was the system in use 64 years ago, and I am quite satisfied that our present arrangements are not so good.

It is found in practice, that not more than 15 forms of light can be used. These forms are given in Plate xxxvii, Fig 1. They are all made with not more than 4 lights at a time. If, therefore, 15 signals were all that could be required for night communication at sea, we might suppose that the want was fulfilled, and neither I nor any one else would have much to say against it. Seeing, however, that 14,000 signals are the requirements of a fleet in the day-time, it would be rather a strain upon our imagination to suppose we could contentedly drop 13,985 of them the moment darkness came on, so that it has all along been the struggle to extend the number of our signals by night to some quantity less disproportionate than 15 to 14,000.

There are some objections to forms of lights which ought to be stated, although I must not be supposed to assert that they are fatal, or that they are of much moment in the face of the greater difficulties into which the forms of lights lead us.

In the first place, an objection lies against any symbol used as a signal in a general system which does not present the same appearance in every direction. It may be seen that there are only four out of the fifteen forms which do this. All the others, therefore, are liable to be mistaken by observers, to whom the form is presented obliquely, or "end on." The practice is to obviate this by continually revolving the signal yard, so as to give every ship a clear view. This is, however, a difficult operation in heavy weather.

The next objection is, the necessity for placing the lights at a considerable distance apart, to distinctly display their form. Lights in form 6 feet apart are not distinct at two miles distance, under the most favourable circumstances, with the naked eye; and the distinctness varies directly as the distance apart. At four miles, therefore, lights in form must be 12 feet apart to be legible. Again, it is generally supposed that the use of more powerful lights in a form makes that form more distinct. This will be true, supposing that the form in which the present lights are displayed, is quite distinct at the moment before the lights disappear from the view. I find, however, both from my own experiments, and also from constant and repeated

inquiries, that the difficulty is not to see the lights, but to separate them into their proper form. It is therefore my opinion, that an increase in the power of the lights we now use, will not increase the legibilty of the signals. I am confirmed in this opinion from having ascertained by experiment, that lights in form so far apart as to be just legible at a certain distance, become illegible when more powerful lights are substituted.

The power of our common signal-lights is unassisted by lenses or reflectors. Supposing that increasing their power would assist us, it is only practicable to do so by means of lenses. But then comes the difficulty of hoisting these lights in such a manner that they shall always remain perpendicular. If they followed the motion of the ship, we have seen that to all observers they will continually appear and disappear; and if they are allowed to acquire a vibratory motion of their own, we shall have first one appearing, and then another, and then none, and so on, rendering the difficulty of reading greater than ever.

I am the more anxious to put this point forward, as we have lately introduced some lens-lights into the service, which are to be used exactly as our common lanterns are; and I am obliged to think that some experiments should take place with them in heavy weather, before we commit ourselves to their use.

But the whole of these objections to light in form, as a means of signalling, are light chaff compared to those which exist; to the means our service has taken to extend the system.

There are, as I have remarked, 15 forms of lights which it is practicable to use. But our night signal book shows us that 103 signals are necessary, and provides that number by means of these 15 forms of lights, multiplied by elements, more arbitrary and unsystematic than the forms themselves. The first of these multipliers is a single light at the masthead—to which the objections are threefold:—First, there is some difficulty in hoisting it; second, when hoisted, it is not easy to say whether it remains alight or not; thirdly, the mast itself will hide the light to a considerable angle on each bow of the ship, and therefore destroy an important element of the signal. The instructions for night-signals lay it down as a rule, that the lights of all signals are to be repeated from each ship. The flag-ship will always find it difficult to ascertain whether the ships astern have repeated the mast-head light, and will therefore be uncertain as to whether her signal is understood.

In a recent case, one line-of-battle ship mistook the signal No. 51, "Wear together,"—which is two lights vertical, a light at the masthead and blue lights or rockets—for the signal No. 3, "Tack in succession," which is simply two lights vertical, and ran into her next ahead in consequence—that ship escaping destruction only by the presence of mind of her officers. Had the offender in question observed the flag-ship's masthead light, the error might have been perceived. Had the flag-ship been certain that the masthead light was not repeated, she would have delayed the evolution until it was so.

The second multiplier used, is rockets, blue lights, or false fires. If

it were possible to make these continuous, the objection to them would not be so great, but who can doubt that the momentary flight of a rocket, or the 25-second flare of a blue-light, will constantly escape observation, and the signal be misunderstood?

The third multiplier is guns, whose use would not be so objectionable out of the enemy's presence, were it not that in 40 of the night-signals they cannot be used, even to call attention, without altering the purport of the signal.

If now the elements of error exist, in each of these multipliers, how will it be when two or more of them are used in conjunction? When we have a form of lights, a masthead light, rockets, blue lights or false fires, and lastly guns, how much chance will there be that some of these four elements composing a signal, may not be overlooked? And yet if any of them are overlooked, the whole purport of the signal will be changed. If the masthead light be not seen, the signal will still be a complete one—so with the rockets, and so with the guns —and it is in this completeness of each part of the signal that the danger lies; the result, in fact, being that our signals by night are very seldom unread, and very often *misread.*

Then, again, difficulties arise from the terribly unsystematic manner in which our night-signals are arranged. In the daytime a signal is made out to be such and such a number, and reference is made to the signal-book for that number. But by night, although the signals are numbered, those numbers are utterly useless, as when a signal is seen, it gives you no clue to its number, and it is necessary to look out for it just according to its composition. Suppose you see four lights horizontal, masthead light, and rockets, you must look to the meaning of such a combination in the code; so that no amount of knowledge, short of learning the whole code off by heart, will assist a person to decipher a night-signal, according to the system used in Her Majesty's navy. Thus, then, we see that the obstructions to the use of white lights in form, as a means of signalling at night, are,

Firstly.—The limit of range, consequent on the practical difficulty of placing the lights far enough apart.

Secondly.—Supposing they could be placed farther apart, the difficulty of using more powerful lights.

Thirdly.—The small number of forms at our disposal.

Fourthly.—The impossibility of combining these forms, as flags are combined in the daytime.

It is therefore hopeless to look in the direction of form alone, for a solution of the problem. Let us then turn to *colour*, and ascertain what assistance may be derived from its use.

At the very outset of this question, we are met by a serious difficulty. Colouring the rays of a white light, interferes with their penetration to a greater or less degree. The deeper the colour, the greater the contrast between it and white light—so much the more is the range limited. Red is the colour which absorbs least light, and yet it diminishes the range by one-third in practice, according to my experiments. Green is still worse, whilst blue almost obscures a light entirely.

Now, it is a law, that if a powerful light and a weak one be placed together, and viewed from a distance, the weaker rays do not affect the eye, and are liable to be lost. Therefore to use coloured and white lights in conjunction, the power of the white lights should be reduced. But we have already been complaining of want of range, and can by no means afford to reduce it still further.

These were the difficulties with which Mr. Mitchell Thomson, in devising a system of coloured lights for naval purposes, had to contend. His proposal, made in 1849, and improved and re-arranged a few years later, consisted in the employment of several green, red and white lights, always in a vertical line, and in such numbers as might be found practicable.

Setting aside the difficulties of colour, the advantages of such an arrangement are very great. First, we get rid of all forms of lights which did not present the same appearance in every direction. Secondly, we arrange a set of symbols to represent the numerals, and then we combine them exactly in the same manner as the flags; and thirdly, we find that so combined, we can display every signal in the night-signal book, without the addition of either guns, rockets or blue lights.

A reference to the table of coloured lights will at once explain the manner of arrangement. (Plate xxxvii., Fig. 2.)

The causes which operated to throw this system aside were only two, but they were fatal.

The same power of light was used in both white and coloured glasses, which produced confused appearances when the lights were hoisted; and though lens lights were used, no preparations were made to obviate the effect of motion on them. However, had both these defects been remedied, there still remained the limit placed upon the range by the use of colour, which is not to be overcome by any amount of skill.

It will be observed that both these systems are general systems as far as they go. It is true that the number of combinations, or groups, is in both cases extremely limited, and that in the first instance many of the rules which regulate a general system proper are thrown aside; but yet both of them intend to display signals in groups of symbols, and to require but one acknowledgment to each group as they follow. These two systems of form and colour are, however, as far as I am aware, the only general ones in use. Modifications occur in some foreign navies, but in principle there is no change.

In the face of the causes which we have seen to exist against the establishment of a "general" system of night-signals, by means of form, color, or both combined, it came to be considered whether the telegraphic principle could not be introduced with success. It was evident that rapidity of change—which I have shown to be the advantage of a telegraphic system—could be produced with greater ease in a small object like a light, than in any other object used in the daytime. All the telegraphic systems of night-signals—and they are numerous—which have been invented with this view, are the produce of the last 15 years.

First on the list comes Mr. Mitchell Thomson with a system using colours the same as proposed for his general system. The difference in arrangement was this:—two white lights only were hoisted. Each of these were provided with a cylindrical red, a green, and a black shade, and these shades were worked by means of small lines from the deck, so that the operator could at will produce either darkness, or any combination of two green, red, and white lights. Such an arrangement was extremely ingenious; but with our senses open to the whole question, it need not surprise us that, being a telegraphic system, it could not fulfil the real wants of the navy, and having, in addition, to contend with the objections to colour, and the lens difficulty, it has fallen into abeyance, from which, I think, there is very little chance of its re-appearing. It is true that the principle has been so far recognized as to allow of its introduction into the night signal-book, but no means are provided for carrying out the plans there laid down.

In my last lecture I explained the universal application of Redl's Cone Telegraph to all circumstances. Advantage has been taken of this characteristic to apply it to two apparatuses for night signals.

The first of these was invented by a man named Hawthorne, now a rigger in Her Majesty's Dockyard, Sheerness. It consisted of four white lights vertical, each light being supplied with a cylindrical red shade only, so that four small lines were required to work them. The *modus operandi* was exactly the same as by the cones in the day time. The red light represented the closed state of the cone, and the white light the open. Thus white, red, red, white, represented the first and fourth cones open, or the figure five. Telegraphing was, of course, extremely rapid with this arrangement, but it laboured under the defect of limited range, and the old difficulty with the lens lights. The arrangement was, however, in my opinion, the very best of form and colour combined which has ever been produced. (Plate xxxvii., Fig. 3.)

The other arrangement on Redl's principle is the work of Commander Sullivan, R.N. It consists of four white lights with dark shades, and a central red light to mark their position. The mode of working was still the same as the cones; but inasmuch as a fifth light was used, I should prefer the previously-mentioned arrangement. (Fig. 4.)

Besides these two plans, I have constantly used Redl's system with any ordinary lights, placing them horizontally instead of vertically, and also with portfires and long lights, and I never knew any of these methods, except Commander Sullivan's, to fail in fixed positions, although, probably, not a single one of them could be used at sea with effect.

The next system to be considered is Admiral Bethune's, which bears a close resemblance to the two just mentioned, but which was I am informed, invented long prior to the publication of Redl's plans.

It consists of four white lights, each with a dark shade, worked by lines from the deck in the usual manner. The possible number of combinations remains at 15 as in Redl's system; but an entirely new element is introduced to extend the number. The changes from 1 to 0 are made by obscuring one light at a time, or two and three together, as shown in Plate xxxvii, Fig. 5. Letters of the alphabet, and further

combinations are made by obscuring lights *in succession*, and then re-showing them in the same order; so that many symbols involve 2, 3, or 4 distinct motions; and this, I must beg you to remark, is the first time we have met with *motion* as a distinct element of a system of signals.

Now, with regard to this system, we see that it is, in the first place, a telegraphic system; and, therefore, lies under the objections before stated. Next, I imagine that there would occur some difficulty in ascertaining when either only 2 lights or 3 lights were showing, without an interval, or some central light to mark it, whether those two or three were the upper or lower lights of the series.

Again we have seen that the aim of a telegraphic system is to *decrease* the number of its symbols; whereas we have here 42 distinct signs to be committed to memory. I should therefore prefer an arrangement more closely following the laws which I imagine to govern in those cases.

Admiral Bethune has paid so much attention to the improvement of signals, and has, as a member of the Board of Trade Committee, assisted so largely in producing what is, in my opinion, the best code of signals ever devised—the Commercial Code—that I regret much, that time, and the limit I have set to my treatment of the subject does not permit me to explain his views on the great question of international communication at sea by signal; views which I feel satisfied we shall one day see thoroughly carried out.

The last system, combining form and colour, to which I have to advert, is Mr. Ward's, which has been largely experimented on; and which, from the perseverance and skill of its inventor, narrowly escaped adoption into our service, as an auxiliary to our present arrangements.

Mr. Ward's system has been latterly somewhat extended; but I prefer to speak of it as it was used in the Channel Fleet, as it is in that form that we best know it.

It consisted of four white lens lights vertical, with red shades, and also with dark shades, worked in the manner before described, by lines—8 in number in this case—from the deck. The red shades gave 15 symbols, and the dark 15 more—30 in all; and these symbols were used to represent the letters and figures annexed to them (Plate xxxvii, Fig. 6).

Now, if the considerations I have placed before you be of weight, we can at once place our fingers on the weak points of this system, and show how the ingenious inventor must ultimately lose his labour from having invented first, and studied afterwards—that evil which has been so great a bar to our advancement.

First, the system is a telegraphic, and not a general one, and, so far, could not supply our great want. Next, it had to contend with all the difficulties of bright and weak lights in proximity, and the limit placed upon its range by the use of red shades. Thirdly, though lens lights, and very good ones, were used, the effect of the lens when made a fixed portion of the ship was overlooked, and thus when the system came to be tried in heavy weather it failed utterly, to the

great perplexity of those who had hitherto seen it answer admirably in fine weather.

But the addition of dark shades to the red ones, when using four lanterns, is also wrong in principle, as the red shades alone give symbols enough for a telegraphic system, and increasing their number is a thing to be avoided.

The error lay in adapting the system to the signal-books, instead of adapting the signal-books to the system. To adapt any signal-book to a telegraphic system, it is only necessary to begin and number every signal in a separate column right through the books, and this would facilitate their use with any system without in the least interfering with that for which they were especially drawn up.

There are other points connected with the practical arrangement of Ward's system, which, did time permit, I should describe, but I cannot part with him without expressing my sense of the value of his exertions in this field, and my admiration of the perseverance he has displayed.

There are two systems combining colour and motion only which have received some trials, and which, on account of the principles involved, it is necessary to touch upon.

Both systems used a single light, and one used green and red shades and the other red only, both having means of obscuring the light entirely.

The symbols were made by a succession of colours, and each change of colour required an acknowledgment. For instance, red followed by green might mean 1, red followed by white 2, and so on, in the one system; whilst in the other, white meant 1, white, red, 2, white, red, white 3, and so on.

Now, we before pointed out that the greater the number of answers required, the more inefficient the system; and as in these arrangements two, and sometimes three, answers were required for each *figure*, we can at once place such systems in their proper place in the scale.

From the number of systems I have touched upon—every one of which, you must bear in mind, is efficient under certain circumstances, and every one of which is inoperative under others—we may gather that the simple invention of a system of signals is the easiest undertaking possible. But the invention of a system which will answer under all circumstances must be by no means so easy, or else we should long ago have been provided with one.

Such a system must be telegraphic and general both; ought not to involve colour, and must not depend on individual skill or great practice. Such a system is, I am satisfied, to be obtained by the use of one element only, namely, *motion*.

Signals of motion, as I explained on Friday last, require but a single object of any kind, and but two positions in which it can be placed. Thus if a collapsing cone be used, the open state will be one position, and the closed state the other. If the arm be used, the erect position will be one, and the hanging state the other. The greatest possible contrast must be secured between the two positions, so that if a light be used, its exposure and concealment form the greatest contrast possible, and thus we have our "flashing signals."

As stated at a former meeting here, Mr. Babbage was the first who put the idea of systematic flashing signals into a definite form. This took place in 1851, although Mr. Goldsworthy Gurney had, in 1839, in his bude-light patent, slightly touched upon the idea. A system of flashes of sunlight has also been used in Algeria.

My attention was first drawn to the subject by Mr. Goldsworthy Gurney, in 1858, who consulted me with regard to its applicability to naval night-signals. My reply to him was what many naval men have since said to me—"It will *never* answer, and if you take my advice, you will give it up." It is quite true that, as then proposed, the system was valueless for naval purposes; but it is no less true that, had I taken up the subject at once, and carried it out into practice, as I have since done, I might have shown you the instruments I here display, four years ago.

I heard nothing more of flashing signals until the year 1860, when, being associated with the Ordnance Select Committee, to arrange a system of signals for the army, Mr. Galton with his Heliostat, and Mr. Way with his electric light, both came forward with proposals to use them for signalling. The subject was referred to my colleague, Captain Ross, and myself, and we then agreed that for fixed positions, a system of flashing signals was practicable. We therefore pointed out, in the first pages of the Army Signal book, two methods by which such signals might be conducted, One proposal was to use the electric telegraph system (Morse's), having reference to the telegraphic staff of the Royal Engineers, whose papers were before us; and the other was to use a system of long and short flashes, based on Redl's cones, for the use of those who were instructed in that system. We were soon after informed that we were to carry out a series of experiments at Plymouth, with Way's electric light, in order to test its applicability to naval and military purposes.

My difficulty was the one, on which I do not think too much stress can be laid, namely, the absolute certainty of want of practice with any system of night-signals; and at first I did not see how to apply the remedy.

At length I invented the instrument of which the following is a description:—The instrument is both a sender and receiver, and as constructed, is only applicable to gas, or Way's electric light. It consists of clock-work moving an endless screw, which lies between two guides or rails. Immediately above it is a small lever, which is insulated from the machine, but is in connection with the upper reservoir of mercury in the light. About a quarter of an inch above the end of the lever is a spring stud, also insulated, but in connection with one pole of the battery. When, therefore, the lever remains down, the circuit is broken, and no light appears; but when the lever is raised, and touches the stud, the circuit is complete, and light is produced. Certain dies are prepared with pins to take the thread of the endless screw, so that its motion may cause them to travel in the guides. These dies have raised notches on their surface corresponding to any determined system of flashes, and each die therefore represents a letter or figure. To transmit a message, it is only necessary to

select the dies representing it, to set the clock-work going, and to place the dies in their guides in their proper order. The flashes will then, as the dies pass under the lever, be delivered with unfailing accuracy, without any exertion of skill on the part of the sender.

To obviate the necessity for skill on the part of the receiver, an arrangement, borrowed from Morse, is used. A strip of paper travels at a uniform rate, under a spring punch; the receiver keeps his finger on the punch, and his eye on the position of the distant light. All that he has to do is, to press upon the punch whenever the light appears. It is evident that by this means he accurately registers the signal made to him, long and short flashes being represented on the strip of paper by long and short marks.

We used these instruments with some success with Way's electric light; but I am bound to say that, scientifically accurate as they may be, they are practically useless.

The experiments were carried on by Captain Ross and myself between a tug at sea and the shore. It happened to be always either raining or blowing, or both, during their continuation; so that we speedily found that something still simpler than the above plan was required. Nice clock-work, and accurately-transmitted flashes, helped one very little when shivering with cold, half under water, and holding on tight to the weather gunwale of the tug. Let me be ever so ready with my register, parts of the rigging, passing vessels, spray, &c., *would* cut off portions of the signals, and leave me in doubt and hesitation.

Our next arrangement was to draw up an alphabet of perfectly arbitrary flashes, and to settle that each letter transmitted was to be continually repeated until answered by the other station. I shall never forget the change this arrangement threw over my ideas on the subject. Hitherto the greatest care and anxiety had been necessary to avoid losing a portion of the signal, but now no care and no anxiety, or strain upon the eye took place. There was each letter "flying" for me to look at and note just when convenient. If the rigging came in the way, I merely waited till it got out of the way. If a passing ship hid the light, it mattered not to me, for I was sure to see the series of flashes going regularly on when she had passed. It is only necessary further to state that, in the course of the experiments, 800 signals were transmitted between the sea and shore after this manner, at a speed of two signals per minute, and that six errors only took place out of that number, whilst the distances varied from two to twelve miles; and the weather was of the worst the whole time.

I was now fully convinced that the great problem of efficient night-signals was approaching solution; and, as soon as my other occupations permitted, I set to work to bring the knowledge I had gained to a practical issue.

I was fully aware, as I am still, that, however we employ special lights for special purposes, ordinary work, both of army and navy, must be performed by ordinary means. It was, therefore, necessary to apply the principle to common lights in the first instance. My first idea for producing the proper results was to place clock-work in the

base of a lantern, which should cause shifting shades, with openings in them, to revolve round the light, and to produce a revolving series of flashes. I found, however, that the waxing and waning of the light, consequent on the slow passage of the openings before it, seriously interfered with the legibility of the flashes. With Way's light, the appearance and disappearance of the light was instantaneous; and I found I could not too closely imitate that characteristic.

I then devised the arrangement shown in Plate xxxvii, Fig. 1, which I have used for nearly two years without material alteration, and with uniform success under every variety of circumstance, and in the heaviest weather at sea.*

For naval use the complete apparatus consists of 1 fitted lamp, 1 signal box, 1 gibbet, for suspending the lamp, and 6 sockets, which are screwed into convenient parts of the ship's side for the reception of the gibbet.

In the interior of the lamp there is a cylindrical shade, which falls by its own weight, and completely obscures the light, when raised by means of the line (C), it completely exposes it, and thus produces flashes of longer or shorter duration. This shade line is connected with a lever, which is acted on by machinery in the signal box. The box contains a revolving barrel, turned by means of a handle, and in its arrangement closely resembling a barrel-organ. The surface of the barrel is occupied by four series of pins and bars, each series representing the flashes given in the table at page 391. They are so arranged that after the first series has passed any point, a slight interval elapses before the next commences, and so on. Between the end of the fourth series and commencement of the first, there is an interval amounting to one-fourth of the circumference of the barrel. The object of these intervals is to separate the figures from one another, and as every signal is continuously repeated till answered, the long interval is required to distinguish the beginning and end of the series transmitted. Parallel to the barrel is a square bar of iron, upon which 5 keys travel horizontally, and above the bar there is a flat brass plate, termed the director, on which four series of figures, from 1 to 0 are engraved, and slots placed opposite to them for the reception of the keys. The revolution of the barrel causes the pins to operate on the keys, which transmit their motion to the lever, and through the line to the lamp shade. It is therefore only necessary to place the keys in the slots corresponding to any series of figures, and then to turn the handle continuously, to produce a revolving series of flashes with unfailing accuracy, and to every point of the compass if necessary. Besides the ordinary numerals, there are several other signs arranged on the barrel so as to give different significations to the figures, in the manner usual with flag signals.

Now what I wish particularly to impress upon you, especially upon my naval hearers, is the fact that we do not in this arrange-

* The apparatus has since been tried continuously in the Channel Squadron for four months, with such remarkable success, that the Lords of the Admiralty have directed the fleet to be completely fitted with it, as well as all the line-of-battle ships and frigates in the Mediterranean.—P.H.C.

FLASHING APPARATUS
FOR THE NAVY.

Fig. 1.

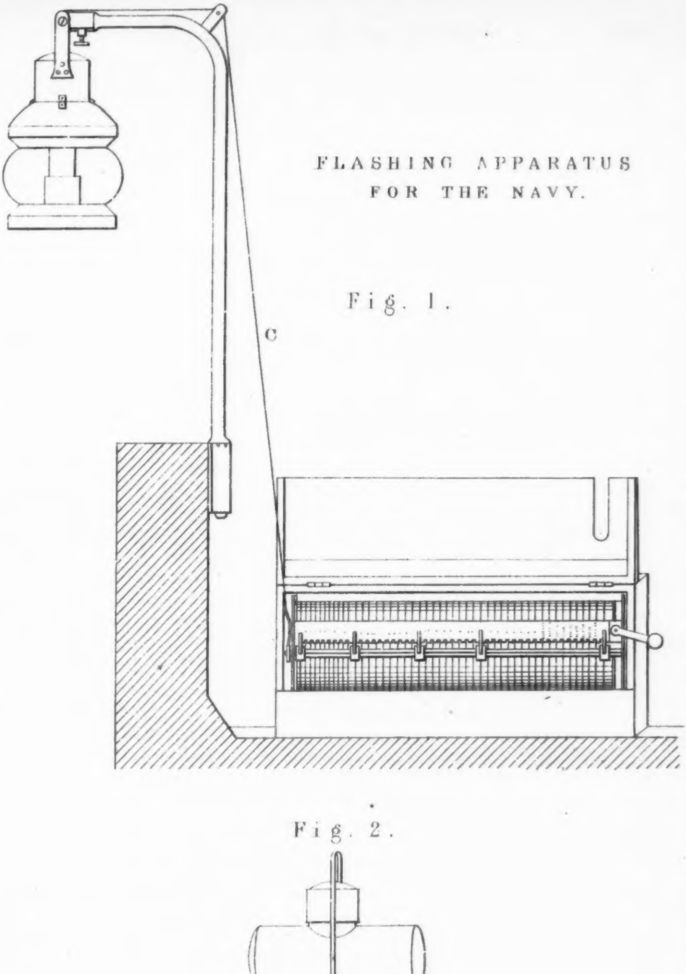
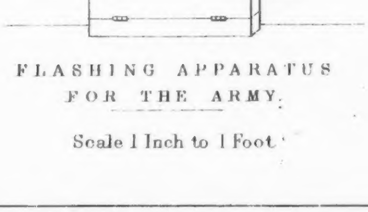


Fig. 2.



FLASHING APPARATUS
FOR THE ARMY.

Scale 1 Inch to 1 Foot.

J.R.Jobbins.

ment transgress one of the rules I have shown to be proper to guide us in the arrangement of a perfect system of signals. We select the simplest symbols possible, we attach numbers or other significations to each of these, and we then combine them and display them in groups, so that *one* answer only is necessary to each group. The system is, therefore, applicable to addressing any number of points simultaneously. It is, therefore, not only a perfect *general* system, but it is also a perfect telegraphic system, for it is evident that the speed of transmission to a single point is only regulated by the speed with which the flashes can be read. If a signal is read the first round of the barrel, it is acknowledged at once, and is not, therefore, repeated. The rate at which the handle is turned increases or decreases the speed at pleasure, and this rate can be made to vary as practice requires.

The best speed I find to be with signalmen nearly twelve figures per minute, that is, nearly three repetitions of a four-figure signal in that time. Very much slower, or very much faster, seem equally to lead to difficulties. In fact, it is very curious to notice the effect of a very slow series of flashes; the memory seems to lose each flash as soon as delivered, and does not connect the *series* sufficiently to recognise it. According to the amount of practice, so does the speed vary; those who have great practice finding a difficulty in reading a slowly delivered signal.

For the use of the army, or, in fact, in any cases of fixed positions, where the signals address but a single point at a time, the barrel is made very small, and the lamp, with proper lenses and reflectors, is fixed on its top. An apparatus available four or five miles, such as is shown in Plate xxxviii, Fig. 2, weighs only five or six pounds, and is easily carried in the hand.

Having now reviewed our system of flashes, it becomes necessary to show its universal applicability, which, indeed, is almost self-evident. Any object, and any sound may be made to do the duty of the lamp-shade; for instance, with a stick and a pocket-handkerchief I can beat, at 2½ miles, using the system described, a set of boats' flags, with expert signalman, both as to speed and correctness. I have also used the hoisting and dipping of a flag, the collapse of a cone or drum, and many other methods, always successfully, and with an amount of ease which surprised myself even.

For distant signals in the day-time from fixed positions, I believe the following arrangement will answer perfectly:—A set of shutters are placed on pivots, something after the manner of a Venetian blind. In their normal state they lie horizontally, so that their edges only are presented to observers, and, at a slight distance, will therefore not be seen at all. A very small motion, it is evident, will produce a very great change in such an apparatus, and the flashes are, therefore, capable of being worked by a somewhat larger description of barrel, its lever causing the shutters to appear perpendicularly to represent flashes, and to return to their horizontal position to represent intervals. Any amount of surface may thus be exposed or withdrawn by a motion comparatively small.

It remains for me now to explain in what way my flashing system differs from that of Captain Bolton, and why I think my own the most useful. But, in fact, those who have followed my arguments with acquiescence throughout, will have anticipated all I could say; or at any rate an inspection of the two tables of flashes used, placed as they are, side by side, will show where the principal objections lie:—

CAPTAIN BOLTON'S FLASHING SIGNALS.

ALPHABET.

A	· —
B	— · · ·
C	— · — ·
D	— · ·
E	·
F	· · — ·
G	— — ·
H	· · · ·
I	· ·
J	· — — —
K	— · —
L	· — · ·
M	— —
N	— ·
O	— — —
P	· — — ·
Q	— — · —
R	· — ·
S	· · ·
T	—
U	· · —
V	· · · —
W	· — —
X	— · · —
Y	— · — —
Z	— — · ·

NUMERALS.

1	·
2	· ·
3	· · ·
4	· · · ·
5	· · · · ·
6	—
7	— —
8	— — —
9	— — — —
0	— — — — —

PARTICULAR SIGNALS.

Attack . .	— · — · — · —
Finis . .	· — · — · — ·
Repeat or ?	· · — — · ·
Numbers .	· · · — · · ·
Understood	·
Erasure. .	· · · · · · · · ·
Period . .	· · · · · ·
Alarm . .	————————

NOTE.—A flash represented by a point is equal to about one-tenth of a second; each bar is equal to three points; a pause of three points to be made between each letter or number, and a pause of six points between each word or set of numbers.

I object, first of all, to the use of many symbols, where they are formed of reversible elements. I use in my system but 22 in all—19 only for the army—and most of these would be very rarely used. Captain Bolton, without providing for the use of a code at all, employs more than double that number.

I object to a system founded on spelling, because our experience in

LIEUTENANT COLOMB'S FLASHING SIGNALS.

TABLE OF FLASHES FOR ALL SIGNAL BOOKS.

1	▬	6	━━━
2	▬ ▬	7	▬ ━━━
3	▬ ▬ ▬	8	━━━ ▬
4	▬ ▬ ▬ ▬	9	▬ ▬ ━━━
5	▬ ▬ ▬ ▬ ▬	0	━━━ ▬ ▬

Preparative . .	▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ &c.
Finish or Stop .	━━━ ━━━ ━━━ &c.
General Answer	━━━ ▬ ━━━ ▬ ━━━ &c.

NOTE.—Two descriptions of flashes are used, the short and the long, the former being about half a second in duration, and the latter about a second and a half.

NAVAL SIGNAL BOOKS.	FLASHES.
Compass	━━━ ▬ ━━━
Pendants	━━━ ▬ ▬ ━━━
Numeral	━━━ ▬ ▬ ▬ ▬
Geographical	▬ ━━━ ▬ ▬
Horary	▬ ▬ ━━━ ▬
Interrogative	▬ ▬ ▬ ━━━
Negative	━━━ ▬ ▬ ▬
List of Navy	▬ ━━━ ▬
Alphabet	━━━ ━━━

ALPHABET.

		A 5		
B 6	C 7	D 8	E 9	F 10
G 11	H 12	I 13	J 14	K 15
L 16	M 17	N 18	O 19	P 20
Q 21	R 22	S 23	T 24	U 25
V 26	W 27	X 28	Y 29	Z 30

the navy teaches us it is not applicable to general purposes; and I prefer a code as a foundation, for the reasons stated in my first lecture.

Finally, I most strongly object, in questions so important as night-signals, to trust to the skill of individuals, who may be out of practice just at the moment when their skill is most required.

The great difference, in short, between Captain Bolton's system and mine is, just this: I can undertake to make an efficient signalman of

a soldier, with the army code and my apparatus, in two day sat the outside. If there be previous acquaintance with the code, one hour is ample for instruction. Three weeks, or 150 hours' training is a *sine quâ non* ere signals can be established on Captain Bolton's system.

It must not, however, be supposed that I do not greatly admire the skill which Captain Bolton has brought to bear on the subject, or that I think the War Department in error in adopting his arrangements *in toto*. In the telegraphic staff of the Royal Engineers they have the skill necessary to work Captain Bolton's system, and it would be altogether wrong to ignore that fact. When, however, they proceed beyond this, then I say they are mistaken in their views.

The actual proposals I have to make for the improvement of our signals may be stated in few words. Into the naval flags I think a gradual abolition of colour might be advantageously introduced, and I should certainly advise the removal of such of them as depend entirely on colour.

For naval and military night-signals I have already described the apparatus. For distant signals between ships and the shore I should employ the ordinary flags afloat, and very powerful telescopes on shore; and between the shore and ships I should recommend the flashing apparatus, with shutters.

For day-signals in the army, I think it might be well to carry out some experiments with black and white flags, in order to test their efficiency; and I also think that signals by motion in their various forms may be found advantageous.

For night-signals in the army, where great range is required, Captain Bolton's arrangements with the lime light seem admirably adapted. I should add to them, however, a small barrel, on my principle, to be fixed permanently to each lamp. This would not preclude the use of the telegraphic alphabet where preferred, but would not leave Captain Bolton's admirable arrangements at the mercy of individual skill.

I should also recommend simpler arrangements than the lime light for the ordinary communications of the army.

I think it will be admitted that these views are sound, for it may be observed that we thus arrange *two* systems only for both army and navy. We secure the practice sufficient for flashing signals in the day-time, by their regular use at night; and we ensure that, in combined operations, the sister services shall be prepared, without any previous notice, to interchange signals without error.

I have only now to close the task I have undertaken, and which I am aware has been but indifferently fulfilled, and I cannot do so without thanking you for the kind manner in which you have listened to me.

Lieutenant Colomb: I should like to say a word or two more. One of the greatest wants that we feel in naval signalling, and one which we should also feel in military signalling, is the means of pointing out the person, ship, division, or squadron that you are addressing. In the day time you have special flags which apply to these different purposes. You require something at night, some means of telling a ship that you are calling *her* attention, and addressing no other. Every ship in the squadron has attached to her a certain number consisting of two figures. These figures are represented by pennants, and whenever a signal is made to a single ship,

these pennants are hoisted with it. You cannot do that safely at night. But you can make these pennants in such a way that they shall not be mistaken for anything else, and then you can make your signal afterwards. We merely set the two first figures, and the fifth key to a series of flashes which is marked "pennants," "long, two short, long." The ship that sees that signal, of course will answer to her number. You go on revolving it until she does see it. If any other ships see it they can repeat it to her, if she does not appear to be paying proper attention. Then you go on with your signal. At the end of your signal you repeat, "pennants," to show that the signal does not belong to anybody else; because a third ship might have seen a portion of the signal without having seen "pennants" at first, and might conclude that it belonged to her. If you conclude with "pennants," as well as begin with it, there can be no possible mistake. You have thus the means of doing every single thing you can do in the day-time with flags. There are nearly 90,000 combinations on the barrel of my signal-machine, and every one of those 90,000 combinations only requires a single answer. Each signal is complete in itself. That is my apparatus for sea purposes. We want in the army something very portable and easily managed. In this case, we don't want to send light in more than one direction. Here we have a little apparatus of the same kind. We now make the signal in this way—2, 5, 4, 1, shut up our box, and turn it in the direction in which we want to make it. There we have exactly the same as in the larger machine, 90,000 combinations. The signals thus made will be visible four or five miles, in fixed positions where you can get the telescope, still further. In the case of fogs where your light signals can communicate but a very short distance, you are obliged to use sound; and as our ships are all steam-ships now, you can use the steam whistle before you very easily, and with it you can make signals by sound; and with this also you have 90,000 changes, exactly the same as you have 90,000 changes with the flashing signals.

Captain Bolton: I have to thank Lieutenant Colomb for the manner in which he has alluded to me. There is really nothing further to be said on the matter; Lieutenant Colomb has treated the subject much more fully than either I or anybody else could have treated it.

The Chairman: Having apparently exhausted the subject, Lieutenant Colomb, I beg to return you the thanks of the meeting for your exceedingly interesting paper.